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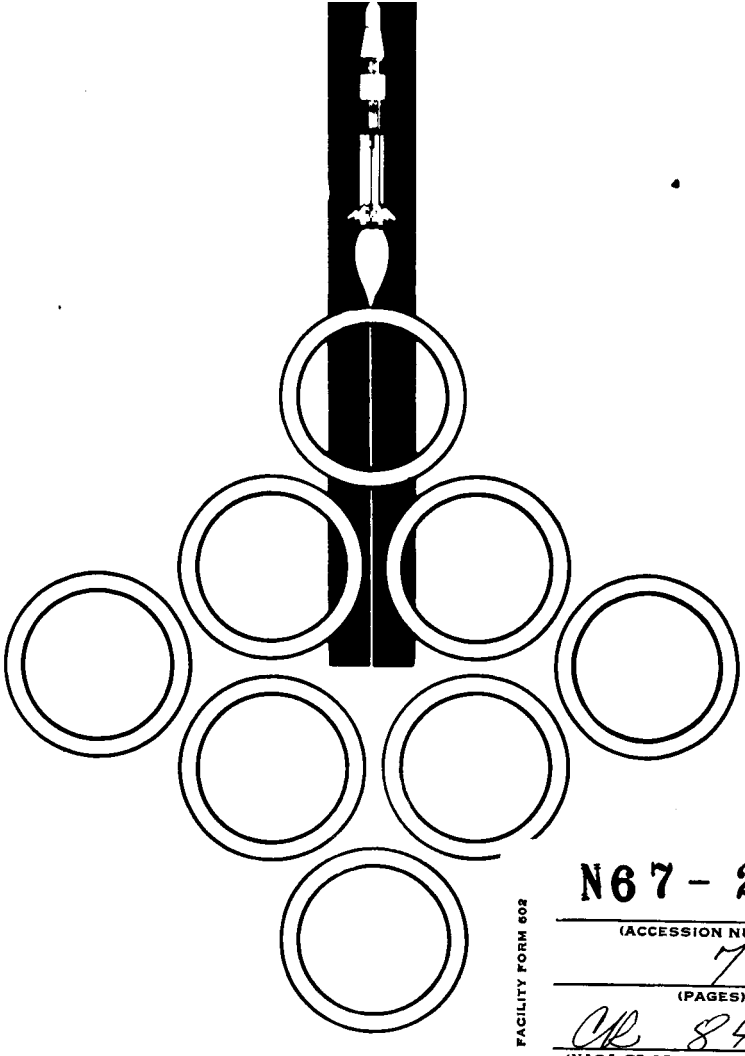


ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1060-3 PHASE E

February 9, 1967

SATURN IB PROGRAM

TEST REPORT FOR

EXPLOSIVE RELEASE

E. I. DuPont De Nemours and Co. Part Number X-696

NASA Part Number X-696

SPACE DIVISION CHRYSLER CORPORATION

TR-RE-CCSD-FO-1060-3 PHASE E

TEST REPORT

FOR

EXPLOSIVE RELEASE

E.I. Du Pont De Nemours and Co. Part Number X-696

NASA Part Number X-696

February 9, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

3226-2-27-67

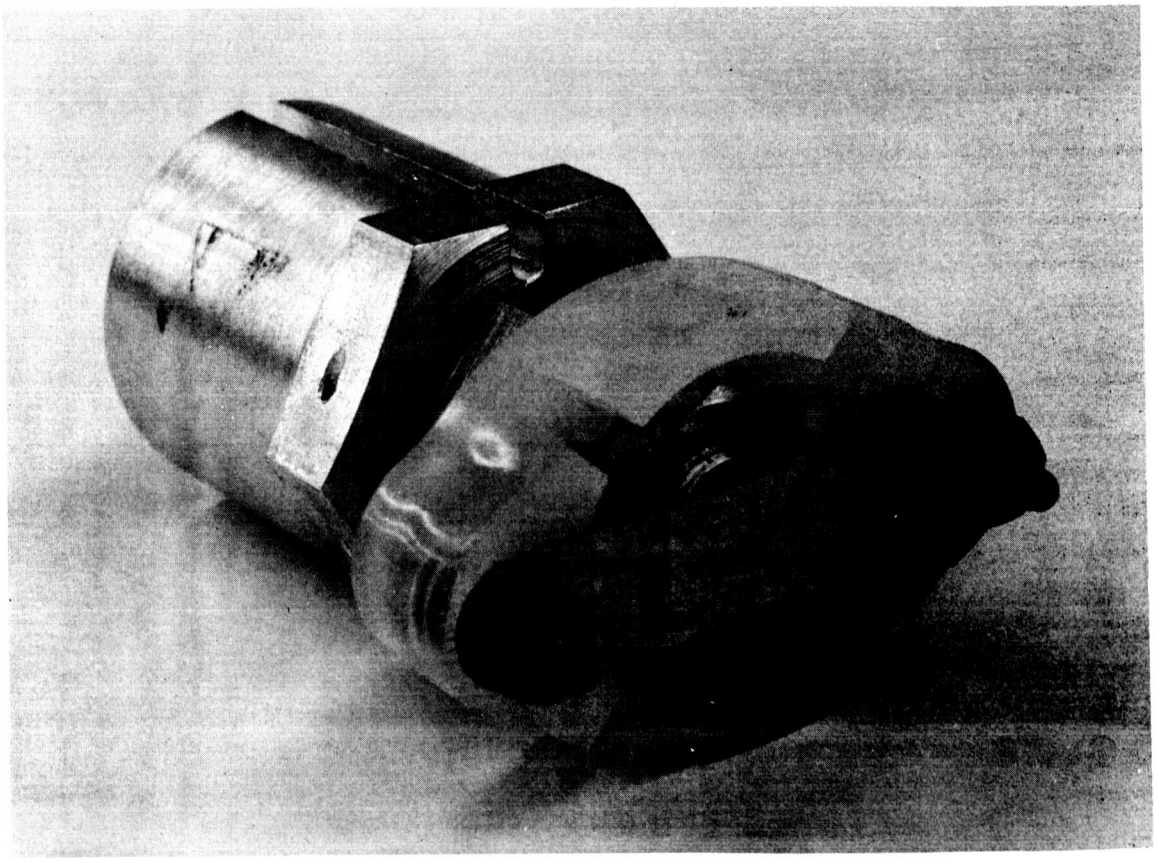
FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under Contract NAS8-4016, Part VII, CWO 271620.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES



Explosive Release

NASA Part Number X-696

CHECK SHEET

FOR

EXPLOSIVE RELEASE

MANUFACTURER: E.I. Du Pont De Nemours and Co.

MANUFACTURER'S PART NUMBER: X-696

NASA PART NUMBER: X-696

TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, La.

AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A. CAP (Du Pont X-692): To detonate at 10 amps current; operating time less than 15 milliseconds

B. METAL PARTS (NUT, BOLT, AND SLOTTED NUT): Slotted nut to separate completely at slot on detonation of cap

II. CONSTRUCTION

A. METAL PARTS (NUT, BOLT, AND SLOTTED NUT)

Material - Non cres hex bar steel

8630 MIL-S-6050 opt.

4130 MIL-S-6758

Heat Treatment - 125,000 to 145,000 psi

Finish - 250 all machined surfaces.

Cadmium plated per QQ-P-416 Type I, Class II

B. CAP (Du Pont X-692)

Leg Wires - Nylon insulated, one blue and one yellow, 22 gage (AWG) tinned copper wire

Rubber Plug - Split rubber plug assembly secured to the leg wires with a welded bridge wire covered with special Du Pont bead mix

Crimps - Completely around the shell

Shell - Commercial bronze

Base Charge - Approximately 15 grains RDX

C. INSULATED PLASTIC BODY

Material - Alathon 20 or 3B

D. SHORTING BAR

Material - Aluminum

III. ENVIRONMENTAL REQUIREMENTS (MANUFACTURING SPECIFICATIONS)

A. CAP (Du Pont X-692)

A "no-fire" test of 1 watt (1.6 amps nominal) for 5 minutes on samples of finished caps

A "sure-fire" test of 10 amps. Functioning time less than 15 milliseconds on sample of finished caps

IV. LOCATION AND USE

A. LOCATION: In the ground support pneumatic system at Launch Complexes 34 and 37

B. USE: The explosive release is a backup, or redundant release, in series with the primary pneumatic release subsystem. The explosive release would be initiated in the event of failure of the pneumatic release assembly.

TEST SUMMARY

EXPLOSIVE RELEASE
X-696

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Vibration - Sinusoidal Search Test	9	Procedure Ia (Ref: KSC-STD -164 (D) page 9-8)	Determine levels and frequencies at which functional degradation occurs	No loss of continuity or premature detonation of specimens during vibration	Test Completed
Vibration - Sinusoidal Sweep Test	9	Procedure Ia (Ref: KSC-STD -164(D) page 9-11)	Determine if specimens are impaired by sinusoidal vibration	No loss of continuity or premature detonation of specimens during vibration	Test Completed
Vibration - Random Vibration Test	9	Level A (Ref: KSC-STD -164 (D) Page 9-5)	Determine if specimens are impaired by random vibration	No loss of continuity or premature detonation of specimens during vibration	Test Completed
High Temperature Test	6 live 6 inert	250°F	Determine behaviour of specimens at elevated temperatures	Plastic bodies of all specimens deformed completely at 250°F with resultant loss of continuity in three live specimens	Test Completed
Temperature Shock Test	3	1000°F	Determine behaviour of specimens under temperature shock conditions	Plastic bodies of all specimens were destroyed by fire that started during test and continued after test completion. One specimen detonated spontaneously three minutes after test completion.	Test Completed

SECTION I

INTRODUCTION

1.1 SCOPE

1.1.1 This report presents the results of tests performed to determine if explosive release X-696 (see figure 1-1) is qualified for use in holddown arm release assembly SK-LUT-2866 and to determine the environmental limits within which the explosive release will operate satisfactorily.

1.1.2 Thirty-six explosive releases were selected as a sample lot and tested as specified in this procedure. A summary of the test results is presented on page ix preceeding the main text of this report.

1.2 ITEM DESCRIPTION

The explosive release is a backup, or redundant release, in series with the primary pneumatic release system of holddown arm release assembly SK-LUT-2866. The explosive release consists of an explosive cap within a bolt and a special slotted nut. The explosive cap is sensitive to a current in excess of 1 ampere and/or 1 watt. Detonation of the explosive cap separates the slotted nut. Ifthe pneumatic release mechanism should fail to operate, the explosive release assembly can be used. The hardware is shown in figure 1-1.

1.3 APPLICABLE DOCUMENTS

The documents used in this test program were:

a. KSC-STD-164(D) Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy

b. Manufacturer's Drawing Numbers 322D, 327A, 766, and 793

c. Test Plan CCSD-FO-1060-1S, Phase E

d. Test Procedure TP-RE-CCSD-FO-1060-2S Phase E

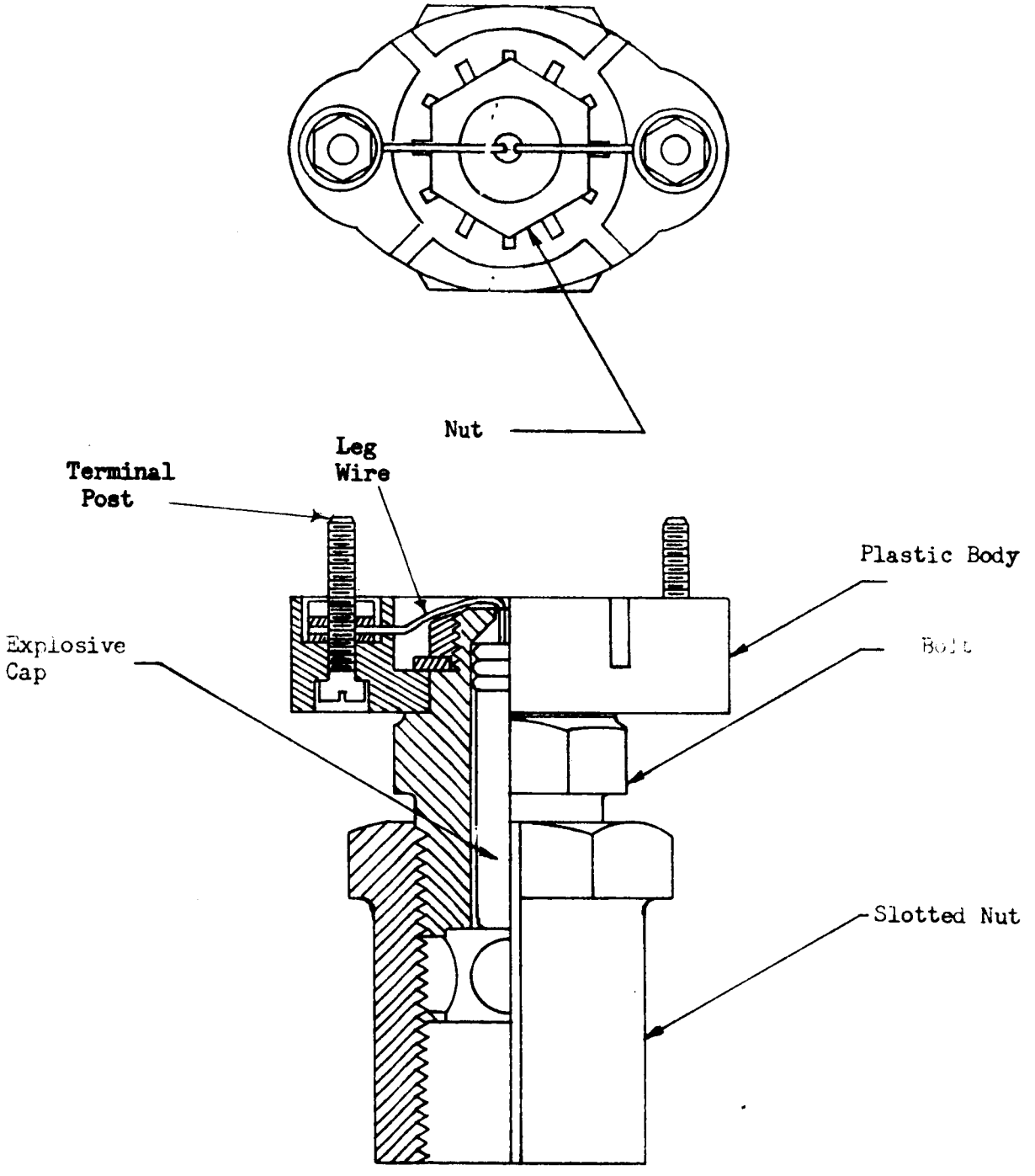


Figure 1-1. Explosive Release X - 696

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

Each test specimen shall be inspected to determine its conformance with applicable documents listed in paragraph 1.3. The specimens shall not be disassembled (except removal of the slotted nut and shorting bar).

2.2 TEST PROCEDURE

2.2.1 A serial number was assigned to each specimen. The serial number was permanently marked on each specimen.

2.2.2 A visual and dimensional inspection was performed to verify that the specimens complied with the applicable manufacturer's drawings and specifications.

2.2.3 The shorting bar was removed and the internal resistance of the explosive charge was accurately measured and recorded using the equipment listed in table 2-1.

2.2.4 Each specimen was inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

2.3.1 The internal resistance of the explosive charges are listed in table 2-2.

2.3.2 No discrepancies were recorded.

Table 2-1. Receiving Inspection Equipment List

ITEM NO.	ITEM	MANUFACTURER	PART NO.	SERIAL NO.	REMARKS
1	IGNITER CIRCUIT TESTER	ALLEGANY INSTRUMENT	—	26505	MODEL 101-5BF

Table 2-2. Initial Internal Resistance Measurements

SPECIMEN SERIAL NUMBER	RESISTANCE IN OHMS
3	.38
5	.40
6	.43
9	.43
11	.37
13	.40
16	.43
18	.39
19	.39
23	.37
26	.39
27	.41
31	.37
33	.40
34	.41
36	.35
37	.42
38	.40
40	.42
42	.40
45	.40
48	.42
49	.42
50	.39
56	.41
69	.37
70	.39
73	.36
74	.38
75	.38
76	.38
78	.41
80	.39
82	.40
83	.39
84	.40

SECTION III

VIBRATION TEST

3.1 TEST REQUIREMENTS

3.1.1 Three sets with nine explosive releases in each set, less the slotted nut, shall be subjected to a sinusoidal search test, sinusoidal sweep vibration, and random vibration, respectively, in accordance with procedure Ia of KSC-STD-164(D). If no functional degradation (failures) occur during the sinusoidal search test, the random vibration test requirements specified in procedure I, figure 9-2, level A, of KSC-STD-164(D) shall be used.

3.1.2 For each test, one set of nine specimens will be mounted in the test fixture so that there are three specimens in each of the three mutually perpendicular axes. The fixture shall be designed so that detonation of one or more specimens will not affect the remaining specimens under test.

3.1.3 SINUSOIDAL SEARCH TEST

The fixture, with the first set of nine specimens installed, shall be exposed to sinusoidal vibration dwelling on each of the 1/3-octave bandwidth center frequencies within the frequency range of 10 to 2000 cps as listed in table 3-1. At each bandwidth center frequency, the acceleration (g) input level shall be increased to the maximum specified in table 3-1 or until functional degradation occurs. In the event of functional degradation, the test shall be continued starting with the next highest bandwidth center frequency.

Table 3-1. Sinusoidal Search Levels

1/3-Octave Bandwidth Frequencies (cps)	Maximum Inputs (g level)
10	1.3
12.5	2.0
16	3.4
20	5.1
25	8.2
32	13.0
40	21.0
50	33.0
62	50.0
80	50.0
100	50.0
125	50.0
160	50.0
200	50.0
250	50.0
320	50.0
400	50.0
500	50.0
630	50.0
800	50.0
1000	50.0
1250	50.0
1600	50.0
2000	50.0

3.1.4 SINUSOIDAL SWEEP

The second set of nine specimens shall be installed in the test fixture and the frequency range shall be scanned logarithmically from 10 to 2000 cps and back to 10 cps for a total sweep of 15 minutes. If no functional degradation occurred during the sinusoidal search test the input levels shown in table 3-2 shall be used. If functional degradation was encountered during the sinusoidal search test, the input levels shall be determined by the test envelope derived from the information gained from the sinusoidal search test.

Table 3-2. Sinusoidal Sweep Levels

Frequency (cps)	Displacement (DA Inch)	Acceleration (g)
10 to 63	0.25	--
63 to 2000	--	50

3.1.5 RANDOM VIBRATION

The third set of nine specimens shall be exposed for 5 minutes to random vibration at a PSD level determined from the formula given in paragraph 9.3.3.2 of KSC-STD-164(D) using the data obtained during the sinusoidal search test. If no functional degradation occurred during the sinusoidal search test, the specimens shall be subjected to random vibration for 5 minutes at the input levels shown in table 3-3. The specimens shall be detonated during the last few seconds of vibration.

Table 3-3. Random Vibration Levels

Frequency (cps)	Slope (db/octave)	PSD (g^2/cps)
10 to 100	+6	--
100 to 1000	--	0.5
1000 to 2000	-6	--

3.1.6 All specimens shall be monitored during the tests, and if electrical continuity is lost or detonation occurs in a specimen, the time the specimen has been under test shall be recorded.

3.1.7 The resistance of each test specimen shall be recorded after the resonant frequency search and the sinusoidal sweep for comparison with the original values. The specimens shall then be detonated with a destruct current of 10 amperes. Actual current supplied and detonation time shall be recorded.

3.2 TEST PROCEDURE

3.2.1 The serial number of each test specimen was recorded.

3.2.2 SINUSOIDAL SEARCH

3.2.2.1 Nine specimens (without the slotted nut) were installed in the test fixture so that three specimens were in each of the three mutually perpendicular axes as shown in figure 3-1.

3.2.2.2 The specimens were electrically connected for internal continuity using the monitoring setup as shown in figure 3-2 and the equipment listed in table 3-4.

3.2.2.3 The vibration control equipment was set to vibrate the specimens at the first frequency level specified in table 3-1 (10 cps). The g level was slowly increased to the maximum specified in table 3-1 and slowly decreased back to zero. The accelerometer locations are shown in figure 3-3.

3.2.2.4 The procedure described in 3.2.2.3 was repeated for each frequency level specified in table 3-1.

3.2.2.5 The actual survey time was recorded.

3.2.2.6 All fixture and test specimen resonant frequencies, and the structural member in resonance were recorded.

3.2.2.7 All test specimen critical frequencies were recorded.

3.2.2.8 The internal resistance of each specimen was accurately measured and recorded.

3.2.3 SINUSOIDAL SWEEP TEST

3.2.3.1 The procedure described in 3.2.2.1 and 3.2.2.2 was repeated.

3.2.3.2 At the rate of 16.5 degrees per minute, the frequency range was logarithmically scanned from 10 to 2000 cps and back to 10 cps at the input levels shown in table 3-2. The accelerometer locations are shown in figure 3-3.

3.2.3.3 All critical frequencies were recorded.

3.2.3.4 The internal resistance of each specimen was accurately measured and recorded.

3.2.4 RANDOM VIBRATION

3.2.4.1 The procedure described in 3.2.2.1 and 3.2.2.2 was repeated.

3.2.4.2 A firing circuit (non-timing) was connected tothe specimens as shown in figure 3-4 utilizing the equipment listed in table 3-5. Power supply 1 was set to provide 10 amperes to each specimen.

3.2.4.3 The test specimens were subjected to random vibration for 5 minutes at the levels given in table 3-3. The accelerometer locations are shown in figure 3-3.

3.2.4.4 During the final seconds of vibration, shorting bar 2 was removed and two (2) specimens were detonated. Each specimen was selected in turn by switch 5 and detonated by the closing of switch 3.

3.2.4.5 After the vibration test was completed, the remaining seven (7) specimens were detonated in the test fixture using the procedure detailed in 3.2.4.4.

3.2.5 OPERATION BY DETONATION

3.2.5.1 The equipment shown in figure 3-5 and listed in table 3-6 was used to detonate and time the eighteen (18) specimens from the simusoidal search and sweep tests.

3.2.5.2 With switch 1 open, variable resistor 2 was connected to the firing circuit and adjusted to equal the resistance of the explosive release.

3.2.5.3 DC power supply 4 was turned on.

3.2.5.4 Knife switch 1 was closed and DC power supply 4 was adjusted to indicate 10 amperes on ammeter 5. The voltage registered on voltmeter 6 was noted.

3.2.5.5 Knife switch 1 was opened, variable resistor 2 was disconnected, and shorting bar 7 was placed in position. Timing power supply 8 was connected to counter 9 and breakwire 10 around the specimen (without the slotted nut). Explosive device 3 was connected to the firing circuit.

3.2.5.6 Shorting bar 7 was removed and switch 1 was closed to initiate detonation and start counter 9.

NOTE: Counter 9 was stopped automatically by rupture of breakwire 10.

3.2.5.7 The specimen was monitored for proper release.

3.2.5.8 The time registered on counter 9 was recorded.

3.3 TEST RESULTS

3.3.1 All test specimens withstood the sinusoidal search, sinusoidal sweep and random vibration environments without loss of internal continuity or premature detonation.

3.3.2 The two (2) specimens detonated during the final seconds of random vibration (step 3.2.4.4) operated satisfactorily.

NOTE: The vibration control equipment could not immediately react to the shock load on the exciter table caused by the detonation of the specimens and was momentarily out of control until the system stabilized. After the first two (2) specimens had been detonated under vibration, it became apparent that there was real danger of damage to the equipment under these conditions. Therefore the remaining seven (7) specimens were detonated after the vibration test was completed.

3.3.3 The seven (7) specimens detonated in the test fixture after the random vibration (step 3.2.4.4) operated satisfactorily.

3.3.4 The serial numbers and initial internal resistances of the

specimens subjected to random vibration are listed in table 3-7.

3.3.5 The serial numbers, internal resistances after test, and detonation times for the specimens subjected to the sinusoidal search vibration are listed in table 3-8.

3.3.6 The serial numbers, internal resistances after test and detonation times for the specimens subjected to the sinusoidal sweep vibration are listed in table 3-9.

3.4 TEST DATA

3.4.1 Data recorded during the sinusoidal search test are presented in table 3-8.

3.4.2 Data recorded during the sinusoidal sweep test are presented in table 3-9 and figure 3-6.

3.4.3 Data recorded during the random vibration test are presented in table 3-7 and figure 3-7.

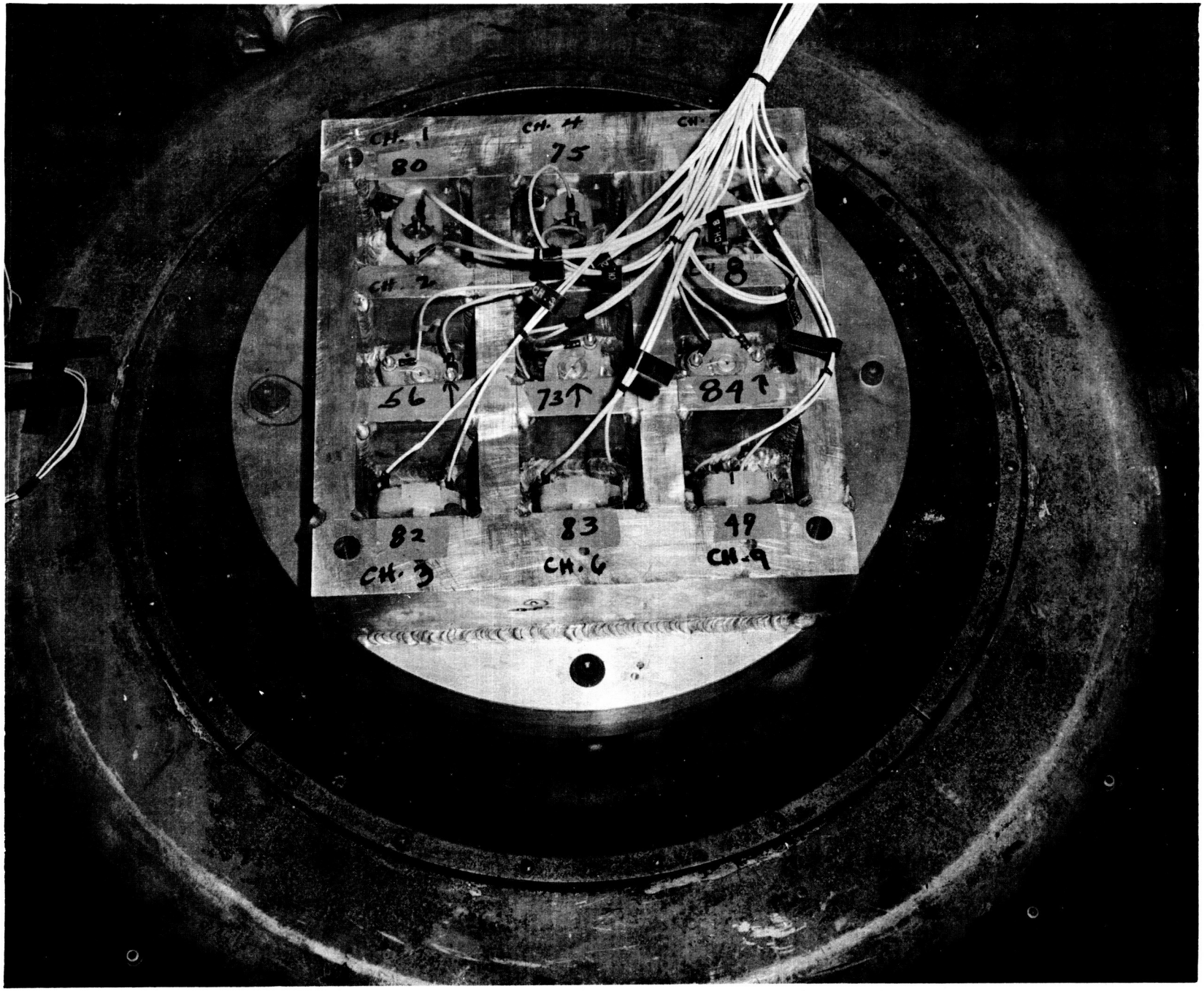
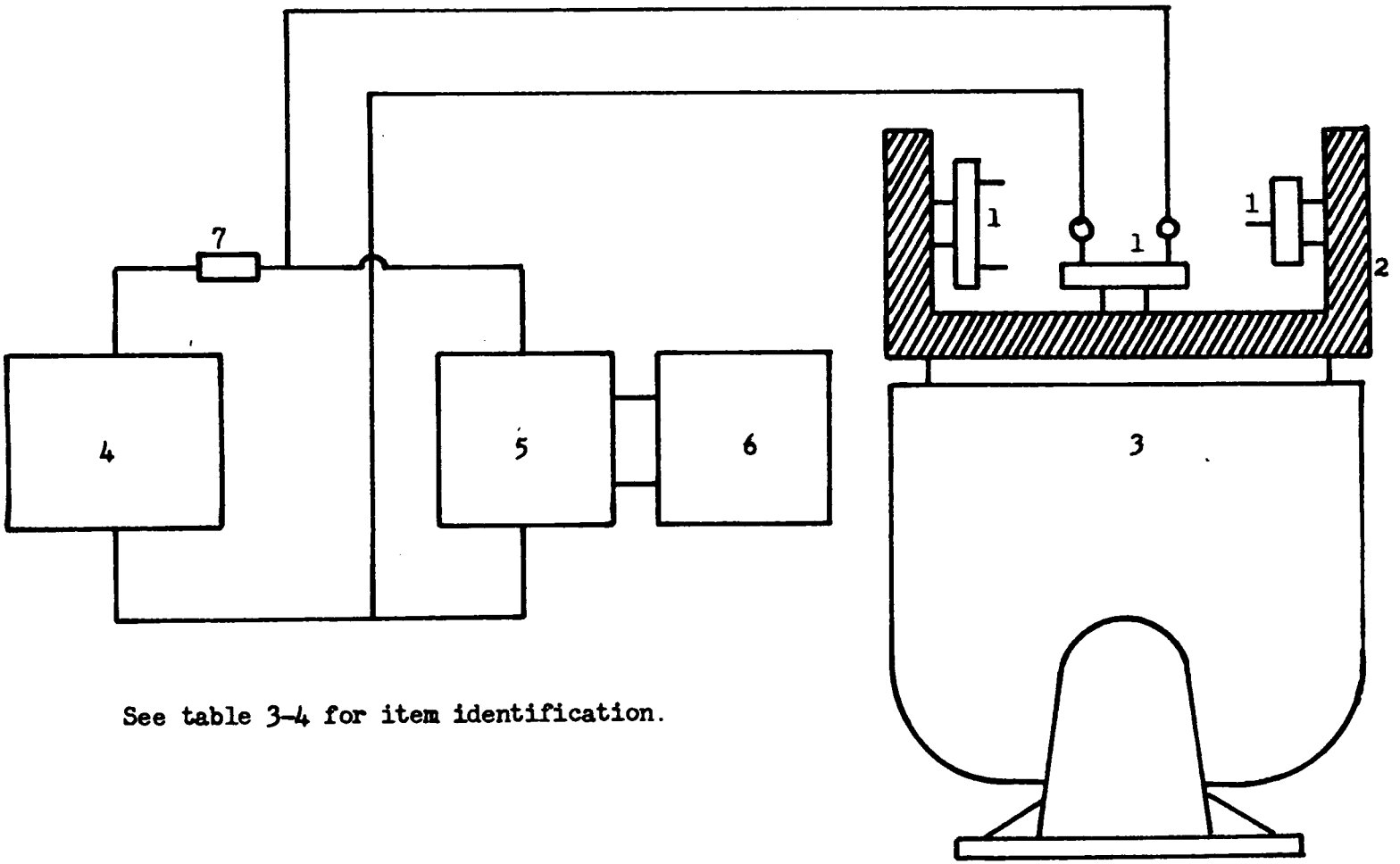


Figure 3-1. Vibration Test Setup



See table 3-4 for item identification.

Figure 3-2. Vibration Test Schematic

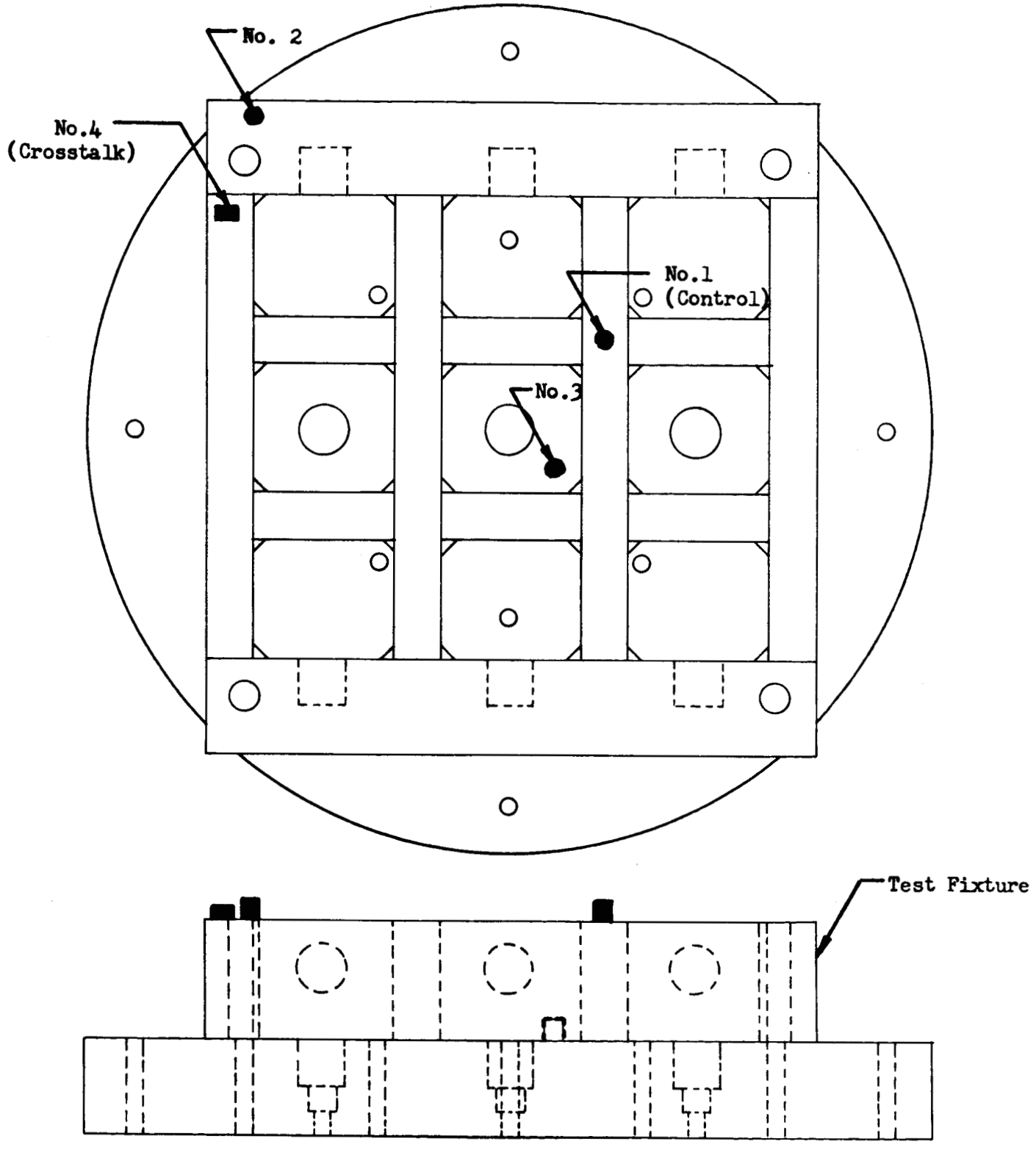
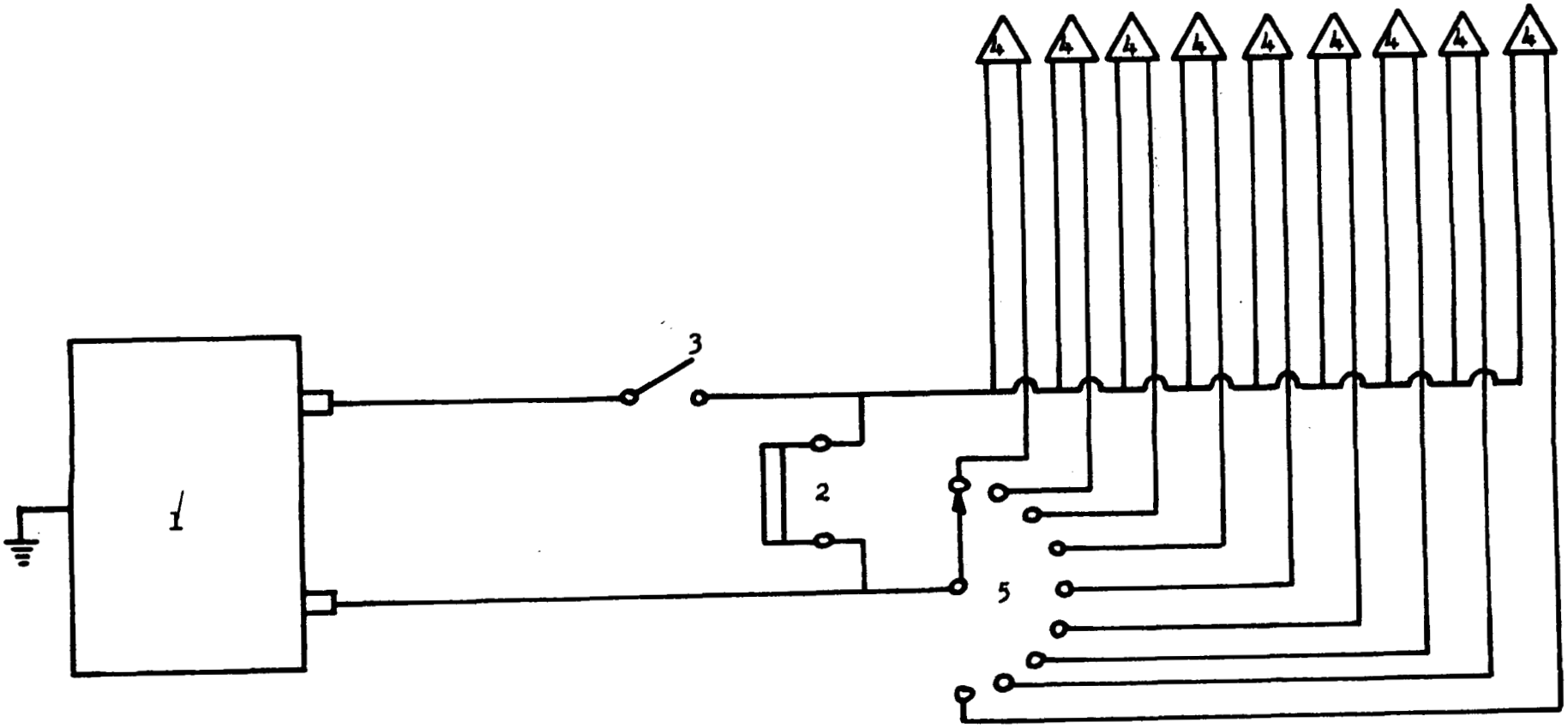
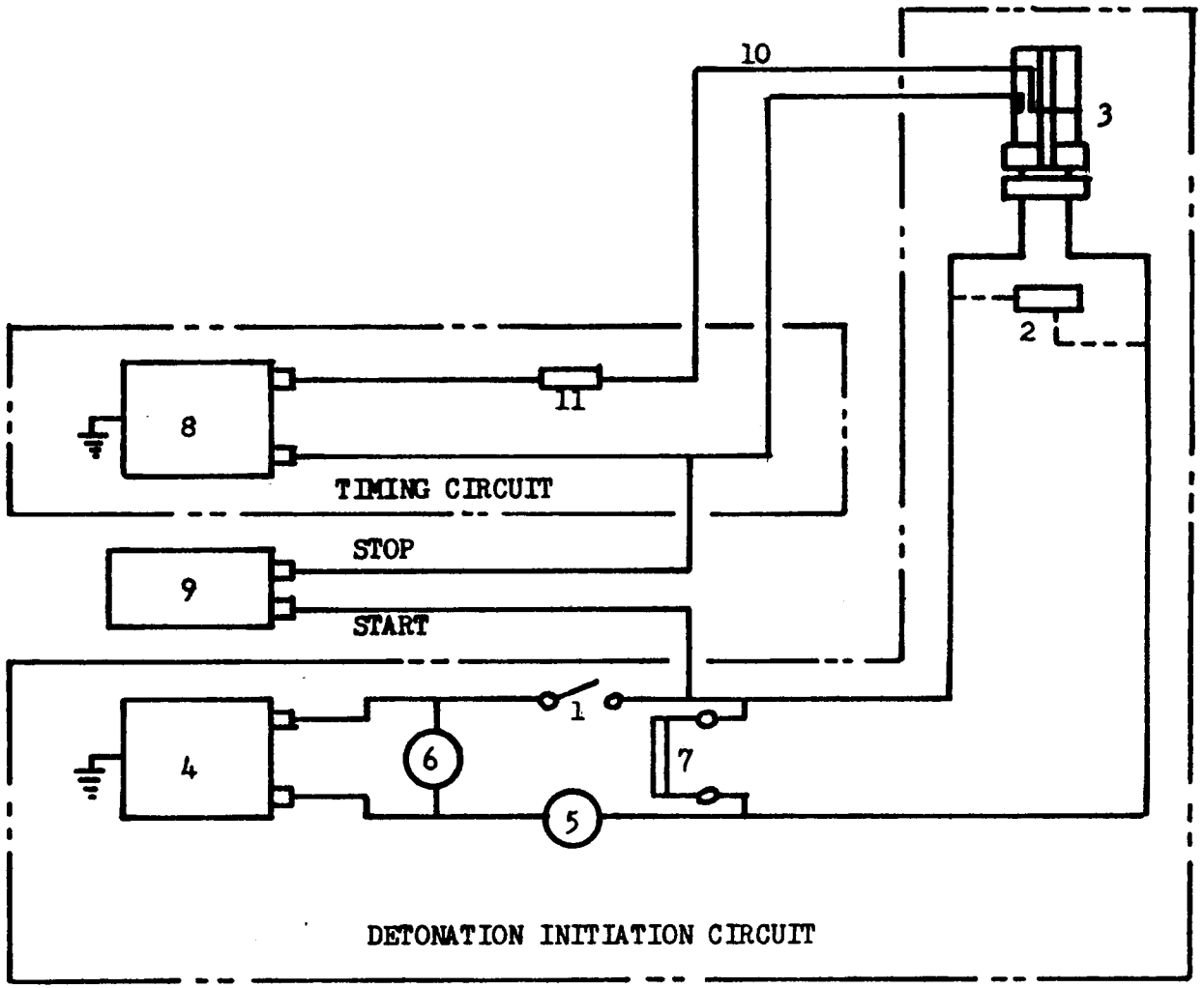


Figure 3-3. Accelerometer Locations



See table 3-5 for item identification

Figure 3-4. Firing Circuit (Non-Timing)



See table 3-6 for item identification

Figure 3-5. Operation by Detonation Schematic

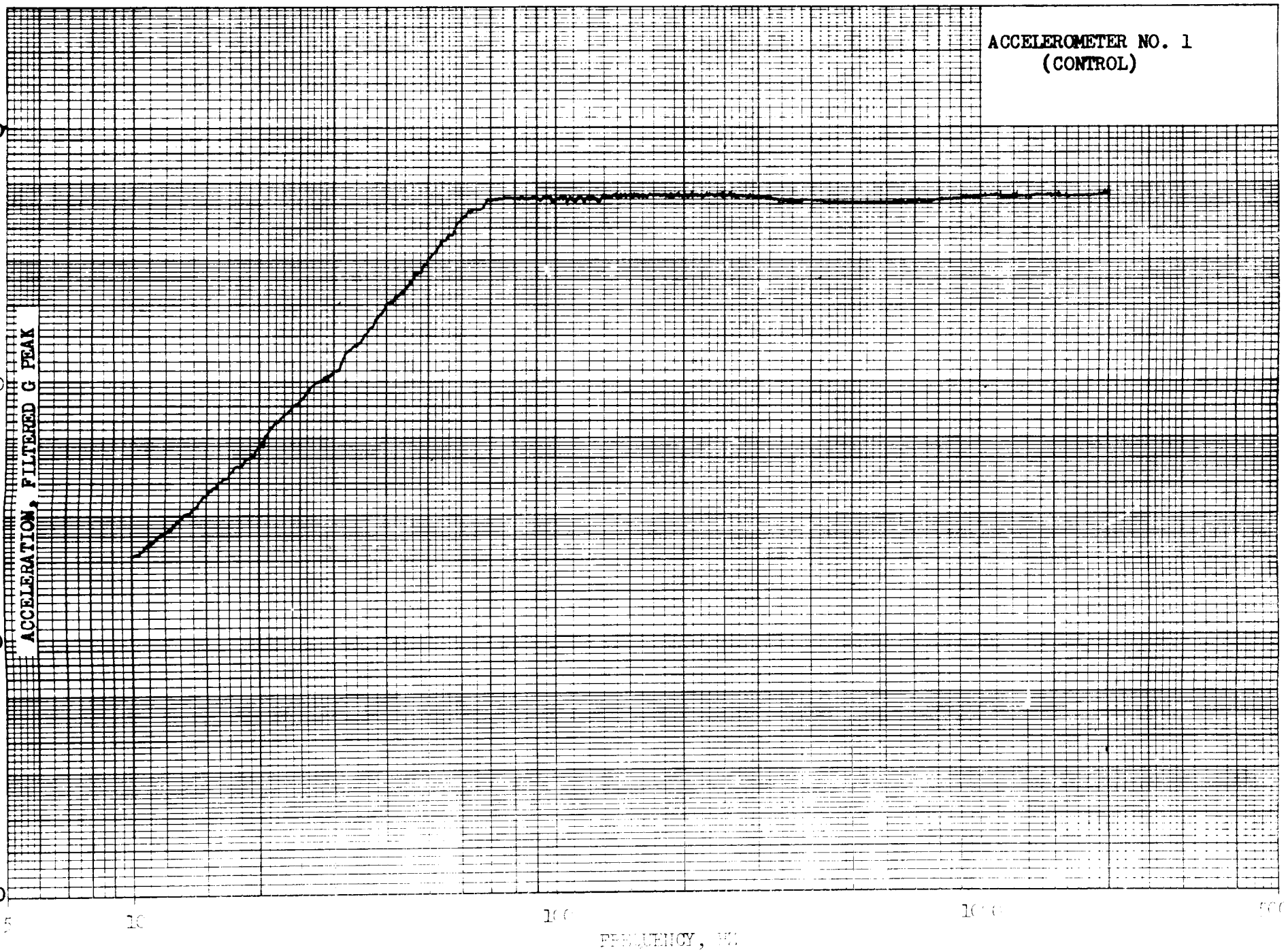


Figure 3-6. Accelerometer Recordings - Sinusoidal Sweep Test (1 of 3)

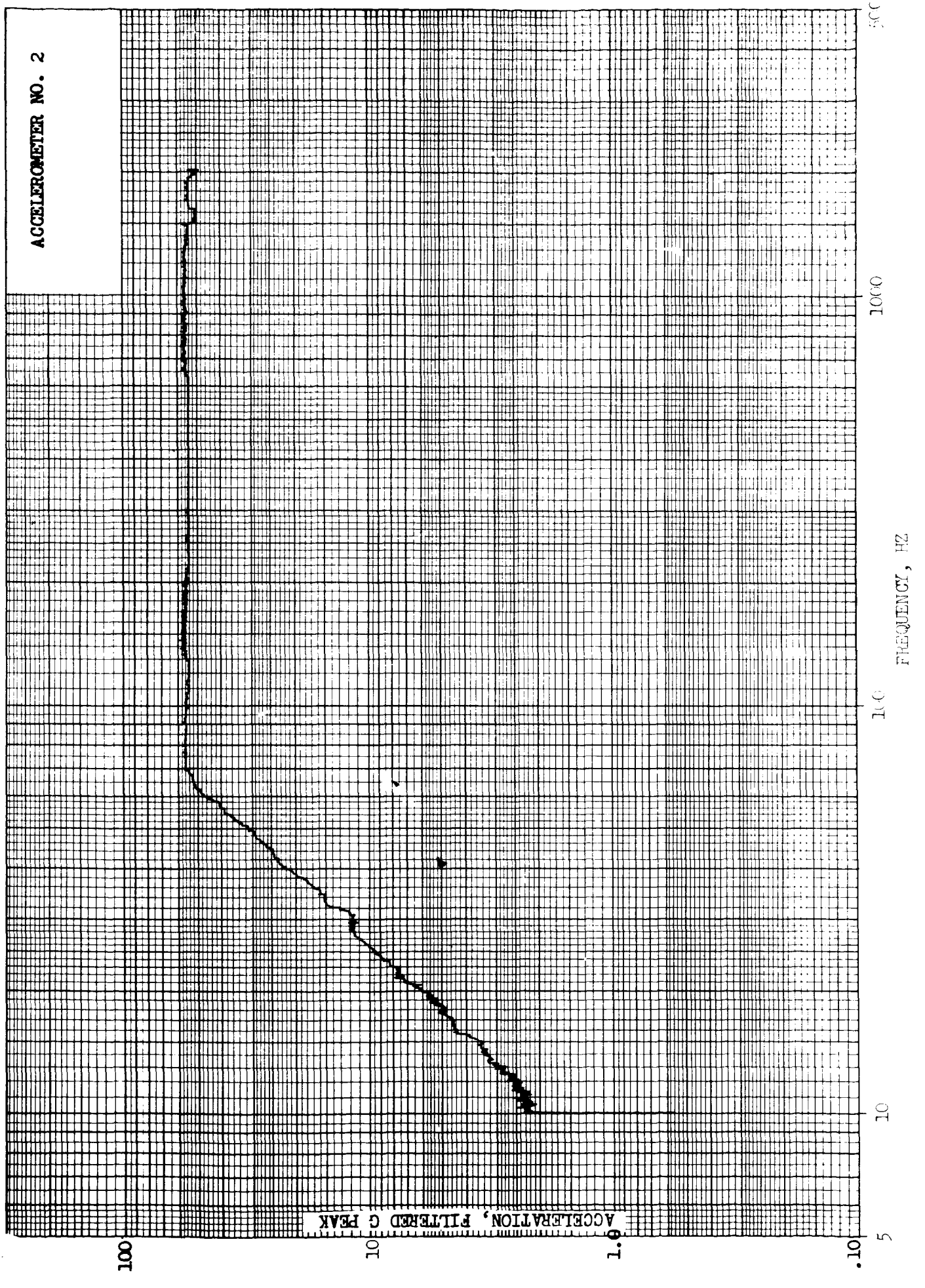


Figure 3-6. Accelerometer Recordings - Sinusoidal Sweep Test (2 of 3)

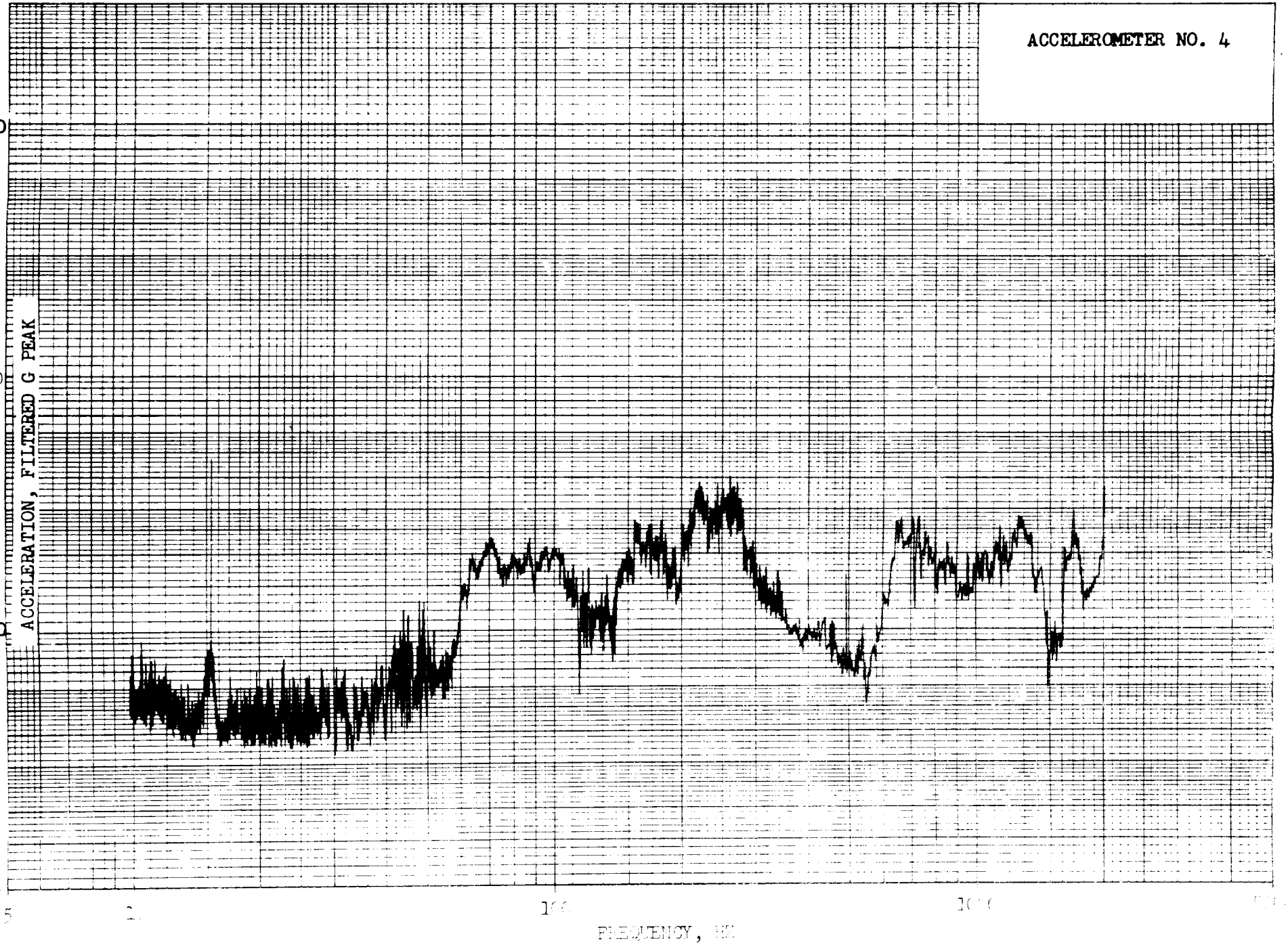


Figure 3-6. Accelerometer Recordings - Sinusoidal Sweep Test (3 of 3)

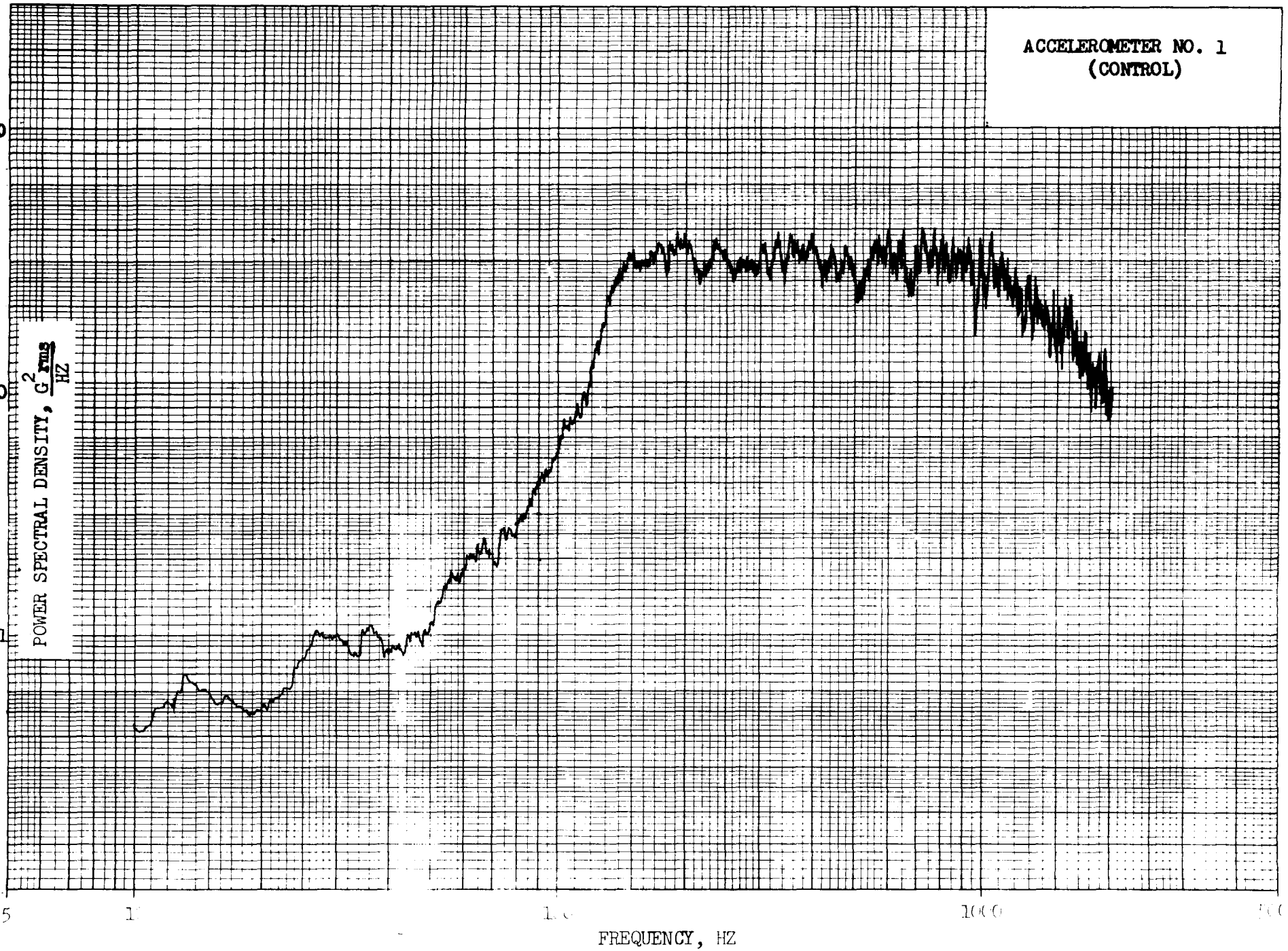


Figure 3-7. Accelerometer Recordings - Random Vibration Test(1 of 3)

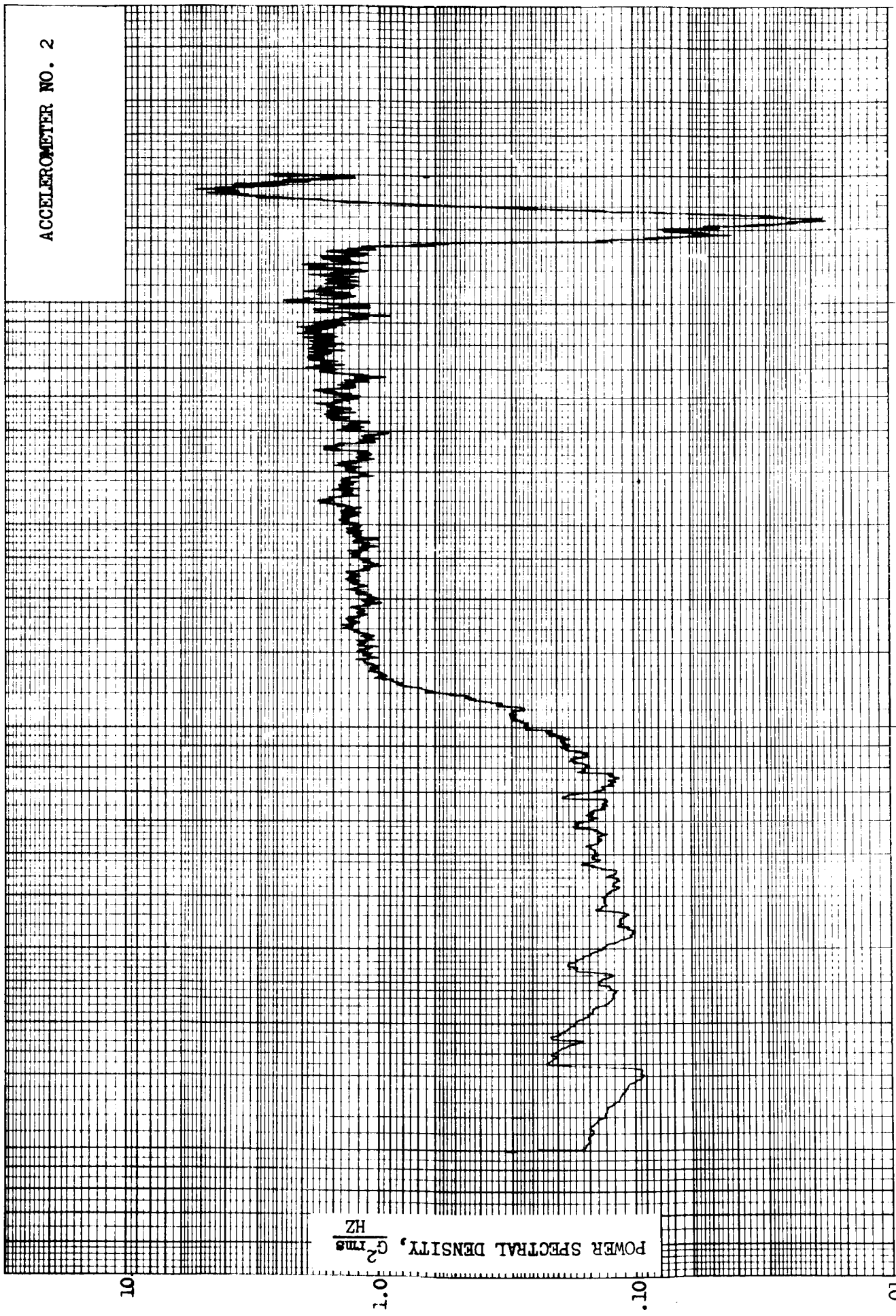


Figure 3-7. Accelerometer Recordings - Random Vibration Test (2 of 3)

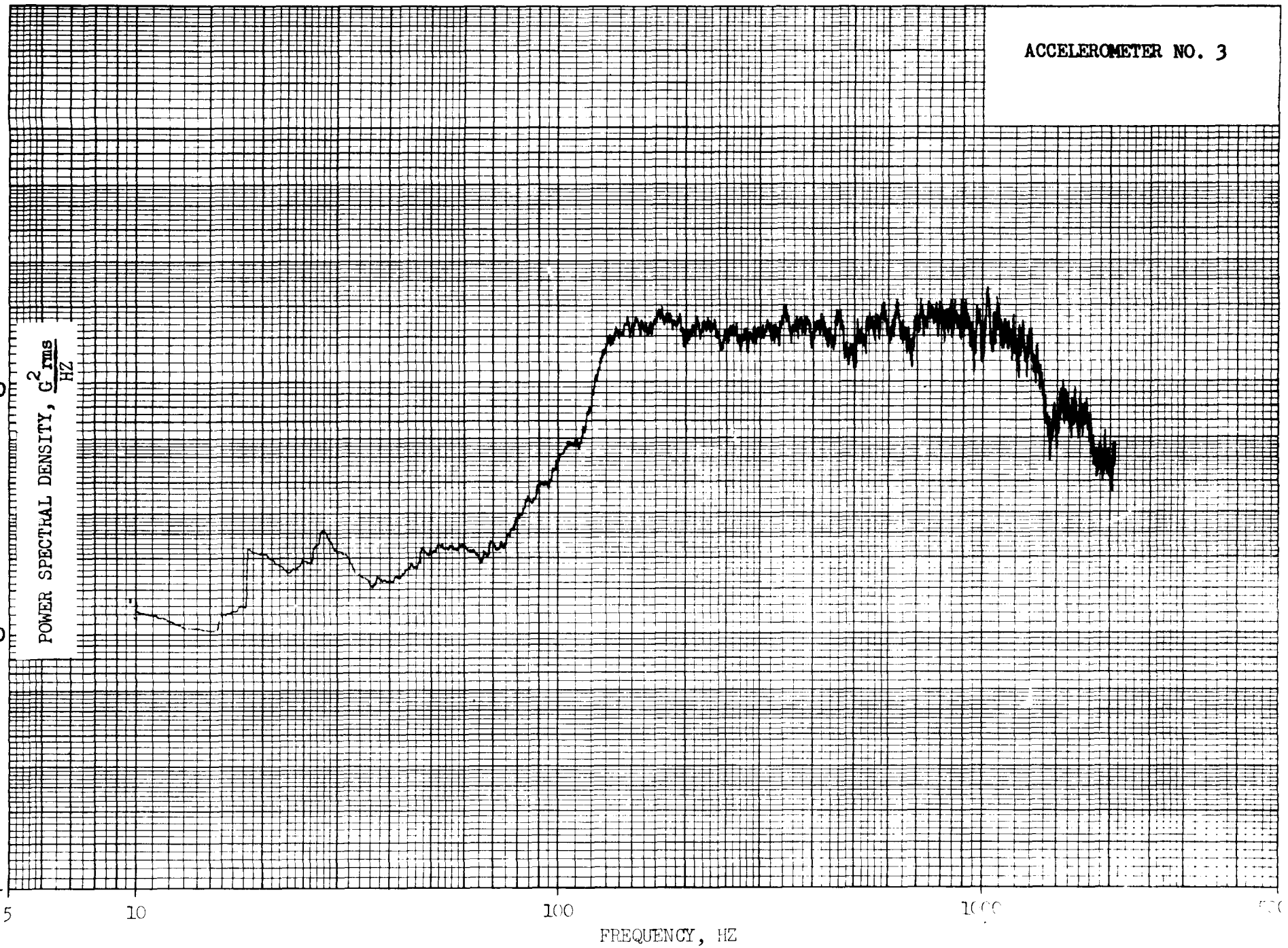


Figure 3-7. Accelerometer Recordings - Random Vibration Test (3 of 3)

Table 3-4. Vibration Test Equipment List

Item No.	Item	Manufacturer	Part No.	Serial No.	Remarks
1.	Explosive Release	E. I. Dupont	X-696	—	9 Specimens
2.	Test Fixture	CCSD	ST 160-104	—	To support 3 specimens in each of 3 major axis
3.	Vibration Exciter	MB Electronics	—	189	Model C126
4.	DC Power Supply	Perkins Electronics	—	64-377	Model TVR 040-5
5.	DC Amplifier	Endevco Corp.	—	—	Model 4621 (9 each)
6.	Oscillograph	Consolidated Electrodynamics Corp.	—	6382	Model 5-124
7.	Resistor	Ohmite	10K	—	Current Limiter

Table 3-5. Firing Circuit (Non-Timing)Equipment List

Item No.	Item	Manufacturer	Model		Remarks
			Part No.	Serial No.	
1.	DC Power Supply	LAMBDA	LA100-03BM	A10281	To provide 10 amps to each of 9 specimens
2.	Shorting	CCSD	—	—	———
3.	Switch	MOSSMAN	—	—	———
4.	Explosive Release	E. I. Dupont de Nemours	X-696	3, 9, 18 31, 34,36 40, 74, 7	Total 9 Test Specimens
5.	Switch	Ohmite	—	—	Specimen Selector Switch

Table 3-6. Operation by Detonation Equipment List

Item No.	Item	Manufacturer	Part No.	Serial	Remarks
1	Knife Switch	Mossman	——	——	——
2	Variable Resistor (R_2)	Ohmite	——	——	Equal to resistance of explosive release X-696
3	Explosive Release	E.I. Du Pont de Nemours	X696	——	Test Specimens
4	DC Power Supply	Lambda	LA100-03BM	A10281	28 VDC
5	Ammeter	Weston	931	——	0- to 20- amp DC ± 1% full scale accuracy.
6	Voltmeter	Simpson	260	——	0- to 30- volt 20 K OHM/VOLT
7	Shorting Bar	CCSD	——	——	——
8	DC Power Supply	Perkin	——	——	TVR 040-5 B. T. 018980
9	Counter	CMC	726-B	——	B. T. 017543
10	Breakwire	Beldin	——	——	#34 HNC NYLCLAD
11	Resistor (R_3)	Ohmite	——	——	5000-ohm, 2-watt

Table 3-7. Random Vibration Test Data

SPECIMEN SERIAL NUMBER	INITIAL RESISTANCE Ω	SPECIMEN TESTING TIME
3	.38	5 mins
9	.43	5 mins
18	.39	5 mins
31	.37	5 mins
34	.41	5 mins
36	.35	5 mins
40	.42	5 mins
74	.38	5 mins
76	.38	5 mins

Table 3-8. Sinusoidal Search Test Data

SPECIMEN SERIAL NUMBER	RESISTANCE Ω		DURING TEST		AFTER TEST DETONATION			REMARKS
	BEFORE TEST	AFTER TEST	CONTINUITY	DETONATION	AMPERES SUPPLIED	VOLTAGE SUPPLIED	ELAPSED TIME MILLISECONDS	
11	.37	.40	Yes	No	10	28 VDC	4.88	
49	.42	.42	Yes	No	10	28 VDC	4.97	
56	.41	.40	Yes	No	10	28 VDC	3.25	
73	.36	.39	Yes	No	10	28 VDC	4.72	
75	.38	.39	Yes	No	10	28 VDC	5.12	
80	.39	.42	Yes	No	10	28 VDC	4.97	
82	.40	.34	Yes	No	10	28 VDC	4.88	
83	.39	.40	Yes	No	10	28 VDC	5.80	
84	.40	.41	Yes	No	10	28 VDC	5.27	

Table 3-9. Sinusoidal Sweep Test Data

SPECIMEN SERIAL NUMBER	RESISTANCE Ω		DURING TEST		AFTER TEST DETONATION			SPECIMEN TESTING TIME	REMARKS
	BEFORE TEST	AFTER TEST	CONTINUITY	DETONATION	AMPERES SUPPLIED	VOLTAGE SUPPLIED	ELAPSED TIME MILLISECONDS		
5	.40	.39	Yes	No	10	28 VDC	3.16	15 mins	
13	.40	.41	Yes	No	10	28 VDC	4.97	15 mins	
23	.37	.36	Yes	No	10	28 VDC	—	15 mins	No time recorded due to equipment malfunction
33	.40	.41	Yes	No	10	28 VDC	5.00	15 mins	
37	.42	.42	Yes	No	10	28 VDC	5.64	15 mins	
45	.40	.39	Yes	No	10	28 VDC	5.43	15 mins	
69	.37	.36	Yes	No	10	28 VDC	5.59	15 mins	
70	.39	.40	Yes	No	10	28 VDC	5.83	15 mins	
78	.41	.43	Yes	No	10	28 VDC	5.34	15 mins	

SECTION IV

HIGH TEMPERATURE TEST

4.1 TEST REQUIREMENTS

4.1.1 EXPLOSIVE CHARGE TEST

4.1.1.1 Six explosive releases with the open end of the slotted nut closed by a threaded plug shall be subjected tothe following temperatures for 1 hour at each temperature level:

1. 175 (± 3)°F
2. 200 (± 3)°F
3. 225 (± 3)°F
4. 250 (± 3)°F

The maximum temperature change rate shall be 1°F per minute.

4.1.1.2 Each test specimen shall be continuously monitored, and in the event that electrical continuity is lost or detonation occurs in a specimen, the time the specimen has been under test shall be recorded.

4.1.1.3 No specimen shall be removed from the temperature chamber until completion of the tests or until all specimens have detonated, whichever occurs first.

4.1.2 OPERATION BY DETONATION

All explosive releases remaining operative after the tests shall be detonated with a destruct current of 10 amps, the destruct current voltage and the elapsed time to detonation shall be recorded.

4.1.3 PLASTIC PARTS TEST

4.1.3.1 Six expended explosive releases from the vibration test (section III) shall be subjected to the folbwing temperatures for 1 hour at each temperature level:

1. 175 (± 3)°F
2. 200 (± 3)°F
3. 225 (± 3)°F
4. 250 (± 3)°F

4.1.3.2 The specimens shall be visually monitored throughout the test and the behavior of the plastic parts shall be recorded.

4.2 TEST PROCEDURE

4.2.1 EXPLOSIVE CHARGE TEST

4.2.1.1 Six explosive releases (serial numbers 19, 26, 27, 42, 48 and 50) were selected as test specimens, and a threaded plug was installed into the open end of each slotted nut.

4.2.1.2 The specimens were electrically connected for internal resistance monitoring as shown in figure 4-1 utilizing the equipment listed in table 4-1.

4.2.1.3 A breakwire was installed around the slotted nut of each specimen and electrically connected for continuous continuity monitoring as shown in figure 4-1 utilizing the equipment listed in table 4-1.

4.2.1.4 The specimens were placed in the electric furnace listed in table 4-1.

4.2.1.5 The temperature was increased in the furnace to 175°F at a maximum rate of 1°F per minute.

4.2.1.6 The temperature was maintained at 175°F (± 3° F) for 1 hour.

4.2.1.7 The temperature was increased in the furnace to 200°F at a maximum rate of 1°F per minute.

4.2.1.8 The temperature was maintained at 200°F (± 3°F) for 1 hour.

4.2.1.9 The temperature was increased in the furnace to 225°F at a maximum rate of 1°F per minute.

4.2.1.10 The temperature was maintained at 225°F(± 3°F) for 1 hour.

4.2.1.11 The temperature was increased in the furnace to 250°F at a maximum rate of 1°F per minute.

4.2.1.12 The temperature was maintained at 250°F(± 3°F) for 1 hour.

4.2.1.13 The temperature in the furnace was allowed to decrease to room temperature.

4.2.1.14 Any loss of electrical continuity or detonation of specimens during the test was recorded.

4.2.1.15 The test specimens were visually inspected and all discrepancies were recorded.

4.2.2 OPERATION BY DETONATION

4.2.2.1 Each specimen remaining operative after the high temperature test was detonated in the set up using the procedure detailed in 3.2.5. The breakwire was placed around the slotted nut.

4.2.2.2 All specimens were removed from the set up and photographed.

4.2.2.3 Each specimen remaining inoperative after the test was detonated using the procedure detailed in 3.2.5.

NOTE: Special electrical connections were made to the explosive charges in these specimens to permit detonation.

4.2.3 PLASTIC PARTS TEST

4.2.3.1 Six (6) of the expended explosive releases used in the random vibration test (serial numbers 3, 9, 18, 36, 40 and 74) were selected as test specimens.

4.2.3.2 The test specimens were placed in the temperature controlled test furnace listed in table 4-2 as shown in Figure 4-2.

4.2.3.3 The temperature was increased in the furnace to 175°F (± 3°F) and maintained for one (1) hour using the equipment listed in table 4-2.

4.2.3.4 Specimen Number 3 was removed and inspected.

4.2.3.5 The temperature was increased in the furnace to 200°F (± 3°F), and maintained for one (1) hour.

4.2.3.6 Specimen number 74 was removed and inspected.

4.2.3.7 The temperature was increased in the furnace to 225°F (± 3°F), and maintained for one (1) hour.

4.2.3.8 Specimen number 36 was removed and inspected.

4.2.3.9 The temperature was increased in the furnace to 250°F (± 3°F) and maintained for one (1) hour.

4.2.3.10 The test furnace was turned off and allowed to cool to room temperature.

4.2.3.11 The remaining three (3) specimens were removed and inspected.

4.2.3.12 On completion of test all specimens were photographed.

4.2.3.13 Throughout the test the specimens were observed, and deformation of the insulated plastic parts were recorded.

4.3 TEST RESULTS

4.3.1 EXPLOSIVE CHARGE TEST

4.3.1.1 No specimens detonated during the test.

4.3.1.2 During the 60 minute soak at 250°F (step 4.2.1.12), internal continuity was lost in specimens 26, 50 and 48 (see figure 4-3).

4.3.1.3 Specimens 19, 27 and 42 remained operative after the test.

4.3.1.4 Visual inspection of specimens 19, 27 and 42 after the test revealed that the plastic bodies of the specimens had been severely deformed during the high temperature cycle.

4.3.1.5 Specimens 26, 48 and 50 remained inoperative after the test. Visual inspection of these specimens revealed that the plastic bodies had been severely deformed during the high temperature cycle, causing a terminal post to fall away from a leg wire in each specimen as shown in figure 4-4.

4.3.2 OPERATION BY DETONATION

4.3.2.1 All specimens detonated satisfactorily.

4.3.2.2 Internal resistance after test and detonation times for specimens 19, 27 and 42 (step 4.2.2.1) are listed in table 4-3.

4.3.2.3 Detonation times for specimens 26, 48 and 50 (step 4.2.2:3) are listed in table 4-3.

4.3.2.4 A photograph of specimens 19, 27 and 42 after detonation is presented in figure 4-5.

4.3.3 PLASTIC PARTS TEST

4.3.3.1 During the 175°F soak (step 4.2.3.3), specimen number 3 sustained no deformation to the plastic body or to the protective plastic tubing on the leg wires.

4.3.3.2 During the 200°F soak (step 4.2.3.5), specimen number 74 sustained no deformation to the plastic body or to the protective plastic tubing of the leg wires, but the plastic body was pliant at temperature.

4.3.3.3 During the 225°F soak (step 4.2.3.7) specimen number 36 sustained slight deformation to the plastic body. No detonation to the protective plastic tubing of the leg wires occurred.

4.3.3.4 During the 250°F temperature soak (step 4.2.3.9), specimen numbers 9, 18 and 40 experienced complete deformation to the plastic body. No deformation to the protective plastic tubing of the leg wires occurred.

4.3.3.5 A photograph of all the specimens after the test is presented in figure 4-6.

4.4 TEST DATA

4.4.1 EXPLOSIVE CHARGE TEST

4.4.1.1 A summary of the explosive charge test data is presented in table 4-3.

4.4.2 OPERATION BY DETONATION

4.4.2.1 A summary of the operation by detonation test data is presented in table 4-3.

4.4.3 PLASTIC PARTS TEST

4.4.3.1 A summary of the plastic parts test data is presented in table 4-4.

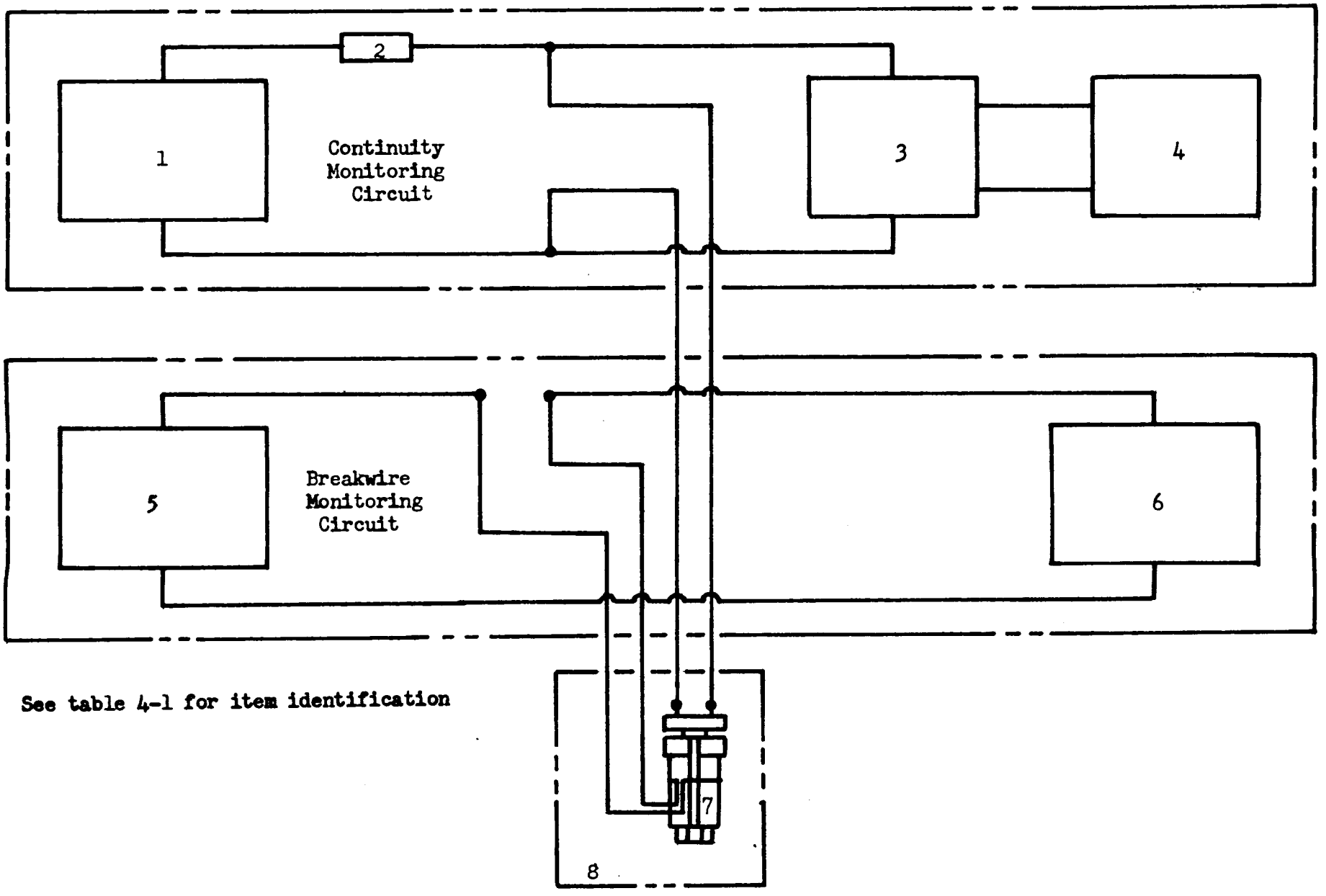


Figure 4-1 . High Temperature Explosive Charge Test Schematic

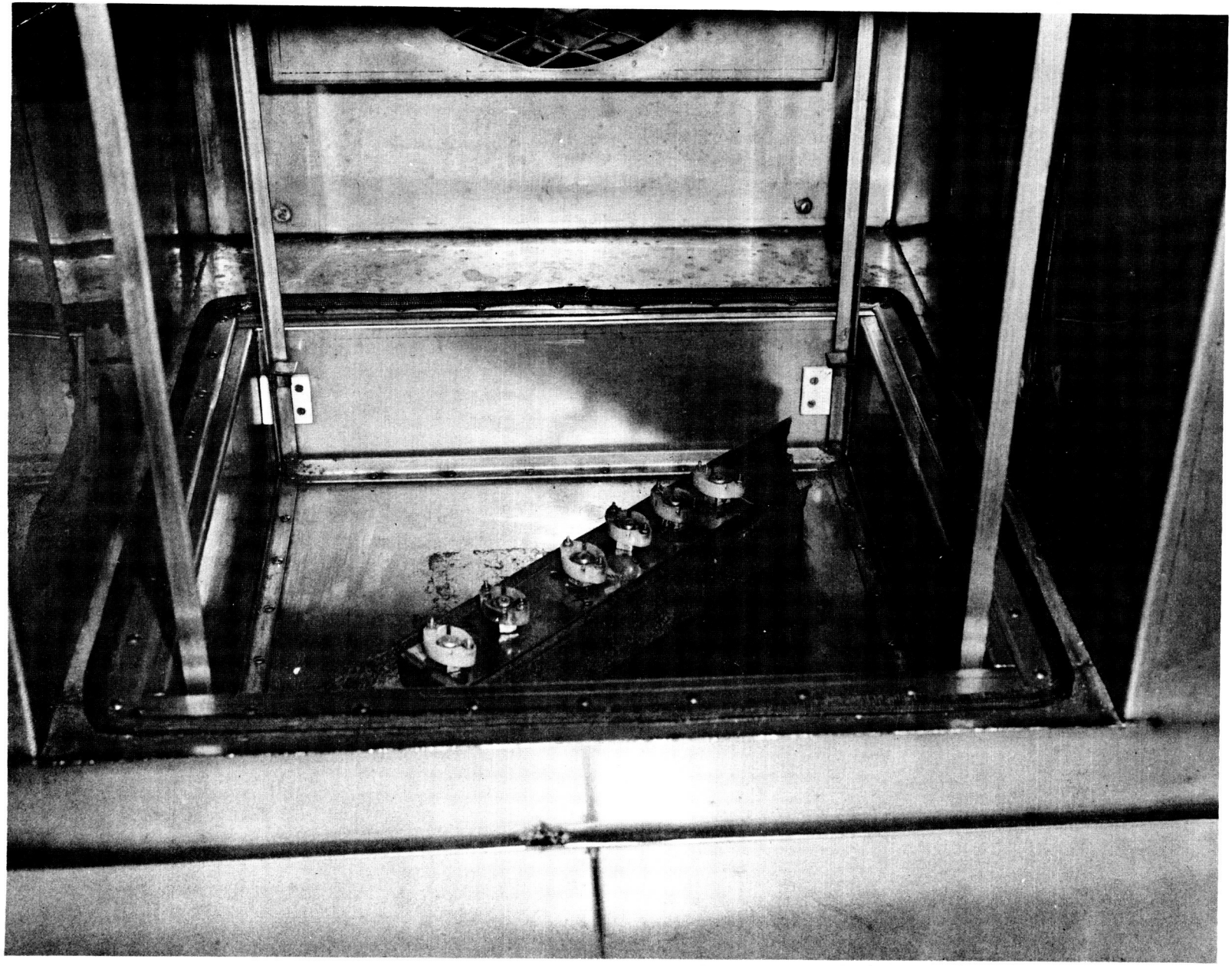


Figure 4-2. High Temperature Plastic Parts Test Setup

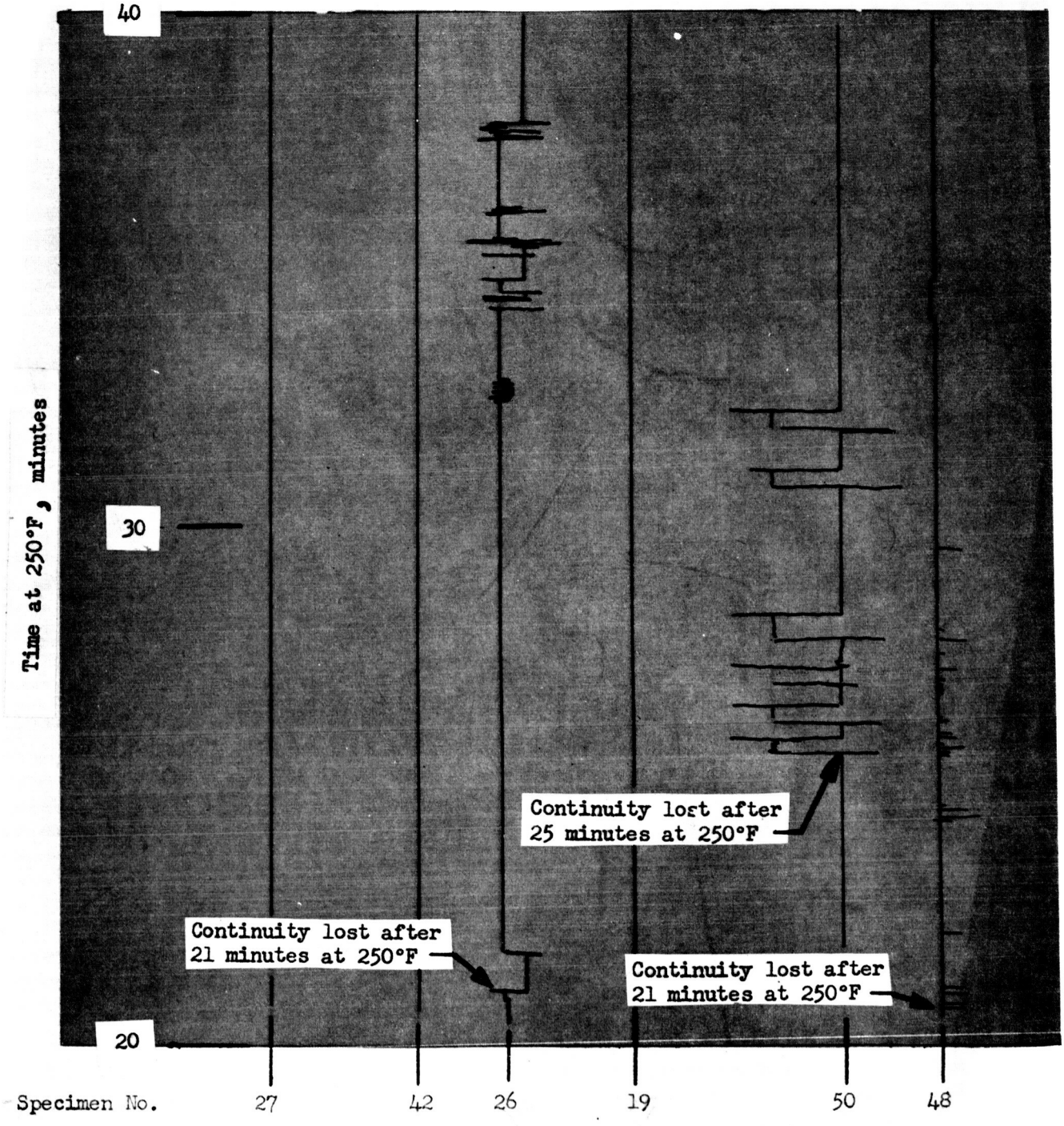
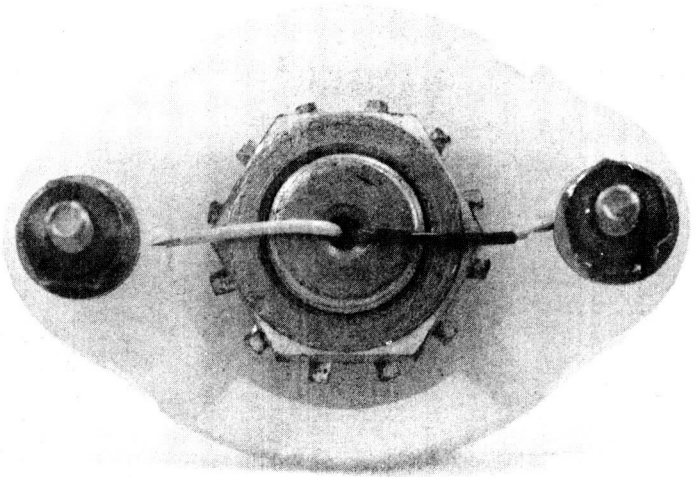


Figure 4-3. High Temperature Explosive Charge Test Continuity Monitoring Recording



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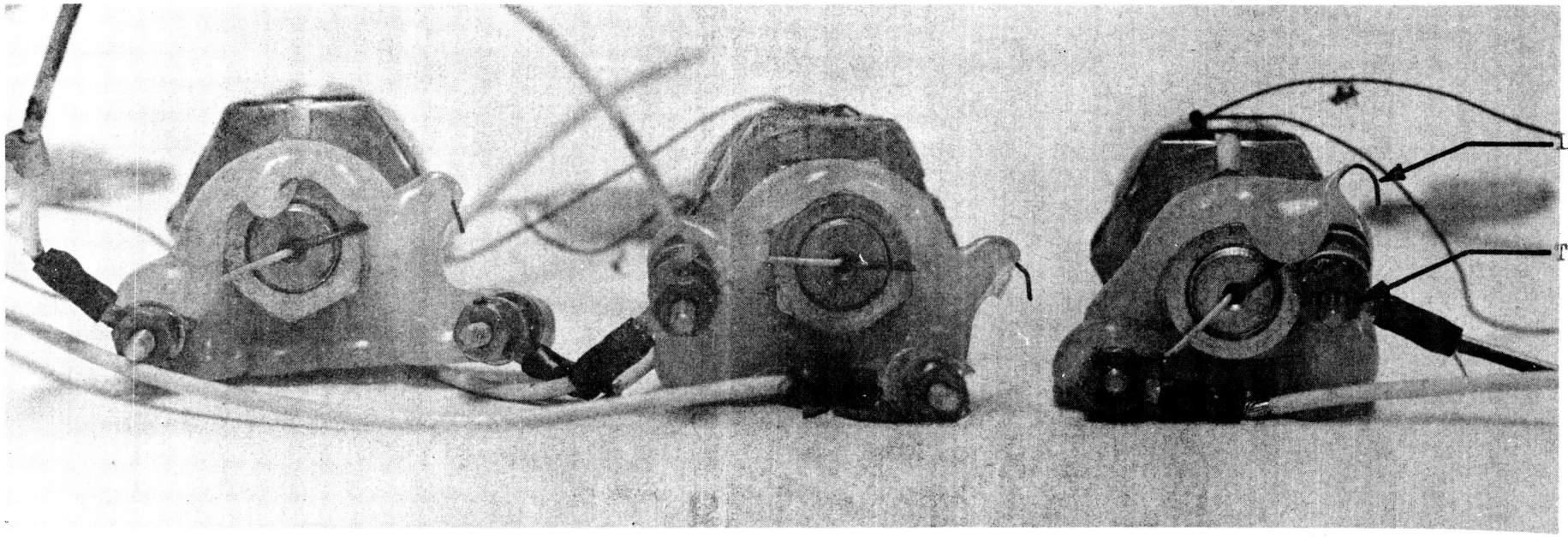


Figure 4-4. Specimens 26, 48 and 50 after high temperature test

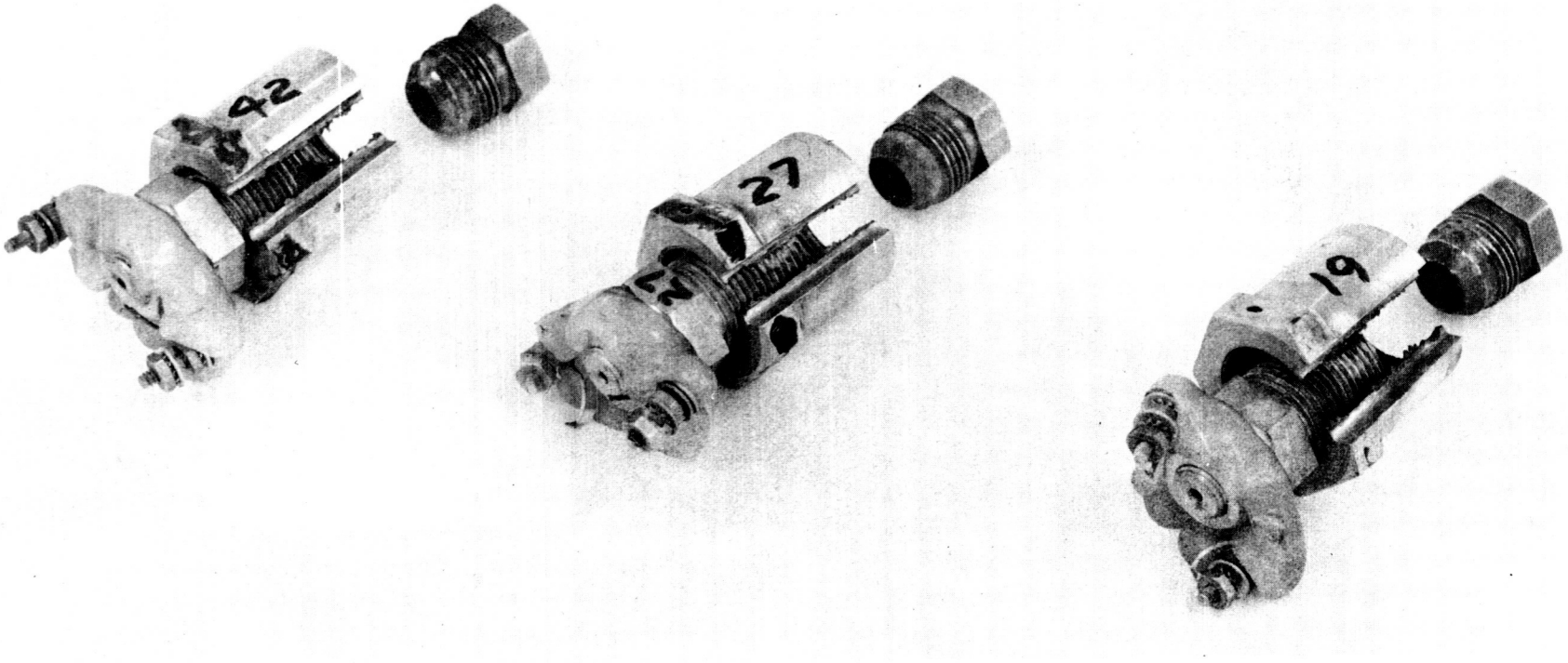


Figure 4-5. Specimens 19, 27, and 42 After High Temperature Tests and Detonation

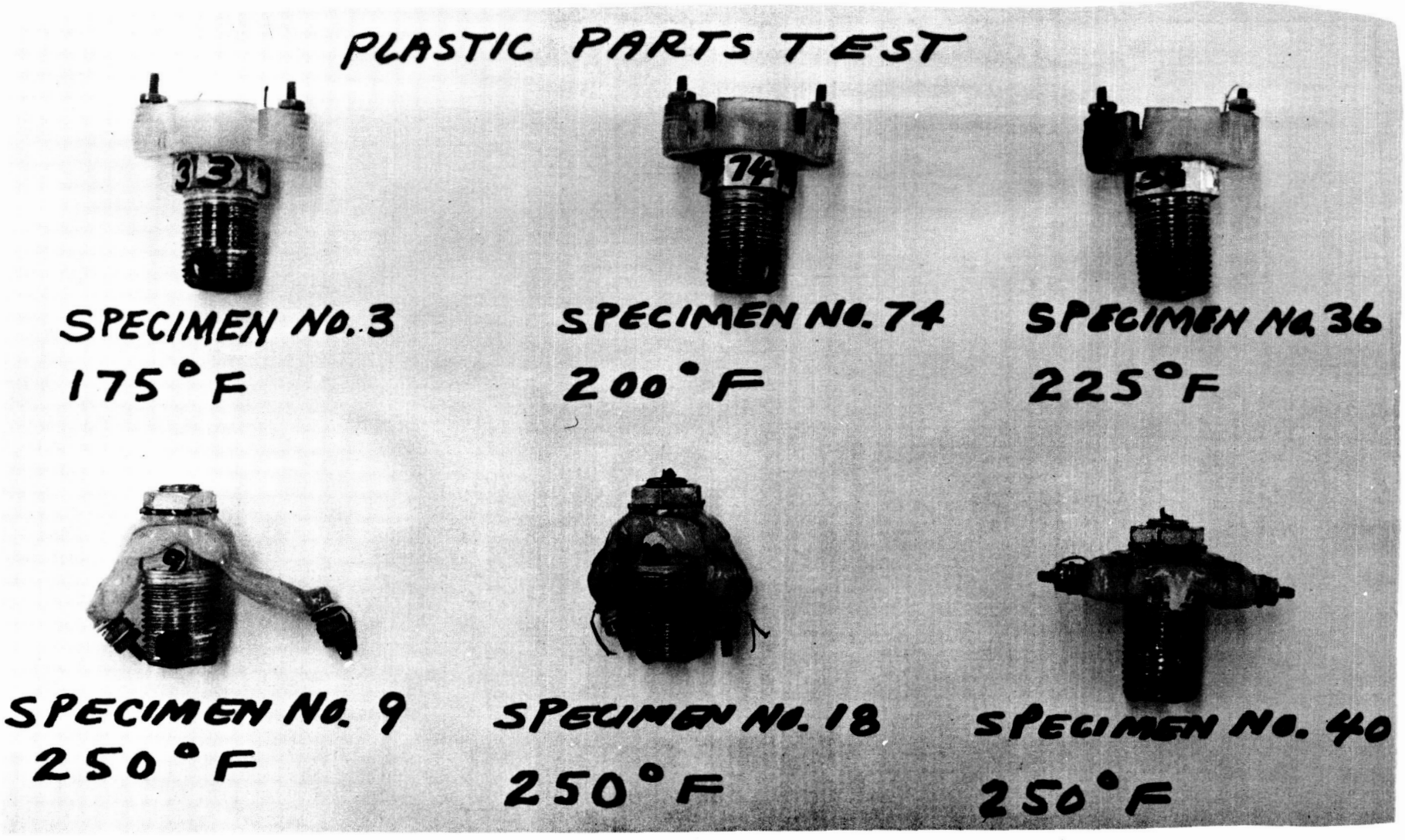


Figure 4-6. Specimens After High Temperature Plastic Parts Tests

Table 4-1. High Temperature Explosive Charge Test Equipment List

ITEM NO.	ITEM	MANUFACTURER	PART NO.	SERIAL NO.	REMARKS
1	POWER SUPPLY	PERKINS ELECTRONICS	—	64-377	MODEL TVR 040-5 5VDC
2	RESISTOR	OHMITE	10K	—	CURRENT LIMITER
3	AMPLIFIER	ENDEVCO CORP.	—	—	MODEL 4621 (6 Each)
4	OSCILLOGRAPH	CONSOLIDATED ELECTRO-DYNAMICS	—	6382	MODEL 5-124
5	POWER SUPPLY	LAMBDA	LA100-03BM	—	28VDC
6	EVENT RECORDER	TECHNI-RITE ELECTRONICS INCORP.	—	—	NASA B.T. 010461
7	EXPLOSIVE RELEASE WITH SLOTTED NUT AND PLUG	E. I. DUPONT dE NEMOURS	X-696	19, 26, 27 42, 48, 50	—
8	ELECTRIC FURNACE	GRIEVE - HENDRY CO.	—	—	NASA B.T. 004488

Table 4-2. High Temperature Plastic Parts Test Equipment List

ITEM	MANUFACTURER	MODEL		REMARKS
		PART NO.	SERIAL NO.	
ELECTRIC FURNACE	CONRAD MFG. CO.	—	—	NASA B.T. NO. 019462
TEMPERATURE CONTROLLER	WEST INSTRUMENT	—	—	NASA B.T. NO. 019462-1
RACK	CCSD	—	—	—

Table 4-3. High Temperature Explosive Charge Test Data

SPECIMEN SERIAL NUMBER	RESISTANCE Ω		DURING TEST		AFTER TEST DETONATION			SPECIMEN TESTING TIME	REMARKS
	BEFORE TEST	AFTER TEST	CONTINUITY	DETONATION	AMPERES SUPPLIED	VOLTAGE SUPPLIED	ELAPSED TIME MILLISECONDS		
19	.39	.48	YES	NO	10	28 VDC	3.30	420 MIN.	DEFORMATION OF PLASTIC BODY OCCURRED DURING THE TEMP. CYCLE
26	.39	NONE RECORDED	LOSS CONTINUITY AT 250°F	NO	10	28 VDC	4.01	420 MIN.	DURING THE TEMP. CYCLE THE LEG WIRES SEPARATED FROM PLASTIC BODY TERMINAL POST.
27	.41	.55	YES	NO	10	28 VDC	4.03	420 MIN.	DEFORMATION OF PLASTIC BODY OCCURRED DURING THE TEMP. CYCLE
42	.40	.54	YES	NO	10	28 VDC	4.85	420 MIN.	DEFORMATION OF PLASTIC BODY OCCURRED DURING THE TEMP. CYCLE
48	.42	NONE RECORDED	LOSS CONTINUITY AT 250°	NO	10	28 VDC	3.87	420 MIN.	DURING THE TEMP. CYCLE THE LEG WIRES SEPARATED FROM PLASTIC BODY TERMINAL POST.
50	.39	NONE RECORDED	LOSS CONTINUITY AT 250°	NO	10	28 VDC	4.62	420 MIN.	DURING THE TEMP. CYCLE THE LEG WIRES SEPARATED FROM PLASTIC BODY TERMINAL POST.

Table 4-4. High Temperature Plastic Parts Test Data

SPECIMEN SERIAL NUMBER	PLASTIC PART BEHAVIOR AT				TEST TIME	INSPECTION REMARKS
	175°F	200°F	225°F	250°F		
3	Satisfactory				165 MIN.	NO DEFORMATION TO THE PLASTIC BODY OR TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.
74	"	PLASTIC BODY IS PLIANT			250 MIN.	NO DEFORMATION TO THE PLASTIC BODY OR TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.
36	"	"	PLASTIC BODY IS PLIANT		335 MIN.	SLIGHT DEFORMATION TO THE PLASTIC BODY. NO DEFORMATION TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.
9	"	"	"	PLASTIC BODY IS MELTED	420 MIN.	COMPLETE DEFORMATION TO THE PLASTIC BODY. NO DEFORMATION TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.
18	"	"	"	"	420 MIN.	COMPLETE DEFORMATION TO THE PLASTIC BODY. NO DEFORMATION TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.
40	"	"	"	"	420 MIN.	COMPLETE DEFORMATION TO THE PLASTIC BODY. NO DEFORMATION TO THE PROTECTIVE PLASTIC TUBING OF THE LEG WIRES.

SECTION V

TEMPERATURE SHOCK TEST

5.1 TEST REQUIREMENTS

5.1.1 Three explosive releases, with the open ends of the slotted nuts closed by threaded plugs, shall be subjected to a temperature of 1000°F for 1 minute.

5.1.2 The test specimens shall be continuously monitored throughout the test, and in the event that electrical continuity is lost or detonation occurs in a specimen, the time the specimen has been under test shall be recorded.

5.1.3 No specimen shall be removed from the test setup until completion of the tests or until all specimens have detonated, whichever occurs first.

5.1.4 All specimens remaining operative after this test shall be detonated with destruct current of 10 amperes.

5.1.5 The actual destruct current supplied and the elapsed time to detonation shall be recorded.

5.2 TEST PROCEDURE

5.2.1 Three (3) explosive releases (serial numbers 6, 16 and 38) were selected as test specimens and a threaded plug was installed into the open end of each slotted nut.

5.2.2 The specimens were electrically connected for internal resistance monitoring as shown in figure 5-1 utilizing the equipment listed in table 5-1.

5.2.3 A breakwire was installed around the slotted nut of each specimen and electrically connected for continuous continuity monitoring as shown in figure 5-1 utilizing the equipment shown in table 5-1.

5.2.4 The three (3) specimens were suspended above the door of the furnace listed in table 5-1. The test set up is shown in figure 5-2.

5.2.5 The furnace was adjusted to maintain a set point temperature of 1000°F.

5.2.6 When the temperature had stabilized at 1000°F, the specimens were lowered into the furnace.

5.2.7 The specimens were removed from the furnace after one (1) minute.

5.2.8 Any loss of continuity or detonation of specimens during the test was recorded.

5.2.9 The test specimens were visually inspected.

5.2.10 All discrepancies were recorded.

5.2.11 Each specimen that did not detonate during the temperature shock test was detonated using the procedure detailed in 3.2.5.
NOTE: Special electrical connections were made to the explosive charges in these specimens to permit detonation.

5.2.12 All specimens were photographed.

5.3 TEST RESULTS

5.3.1 Dense smoke appeared from the furnace as soon as the specimens were placed inside.

5.3.2 Throughout the test, intermittant loss of continuity was recorded from specimens 6 and 38 as shown in figure 5-3.

5.3.3 None of the specimens detonated during the test.

5.3.4 The plastic bodies of all test specimens were on fire when the specimens were removed from the furnace.

5.3.5 The behaviour of the specimens after the test was completed is described in the following paragraphs.

5.3.5.1 The plastic bodies of the specimens continued burning after the test was completed.

5.3.5.2 The plastic bodies of all specimens were destroyed by the fire and the leg wire terminal posts fell from all specimens.

5.3.5.3 Specimen No. 16 exploded while on fire, three (3) minutes after the completion of the test. The post-test breakwire monitoring record is presented in figure 5-4.

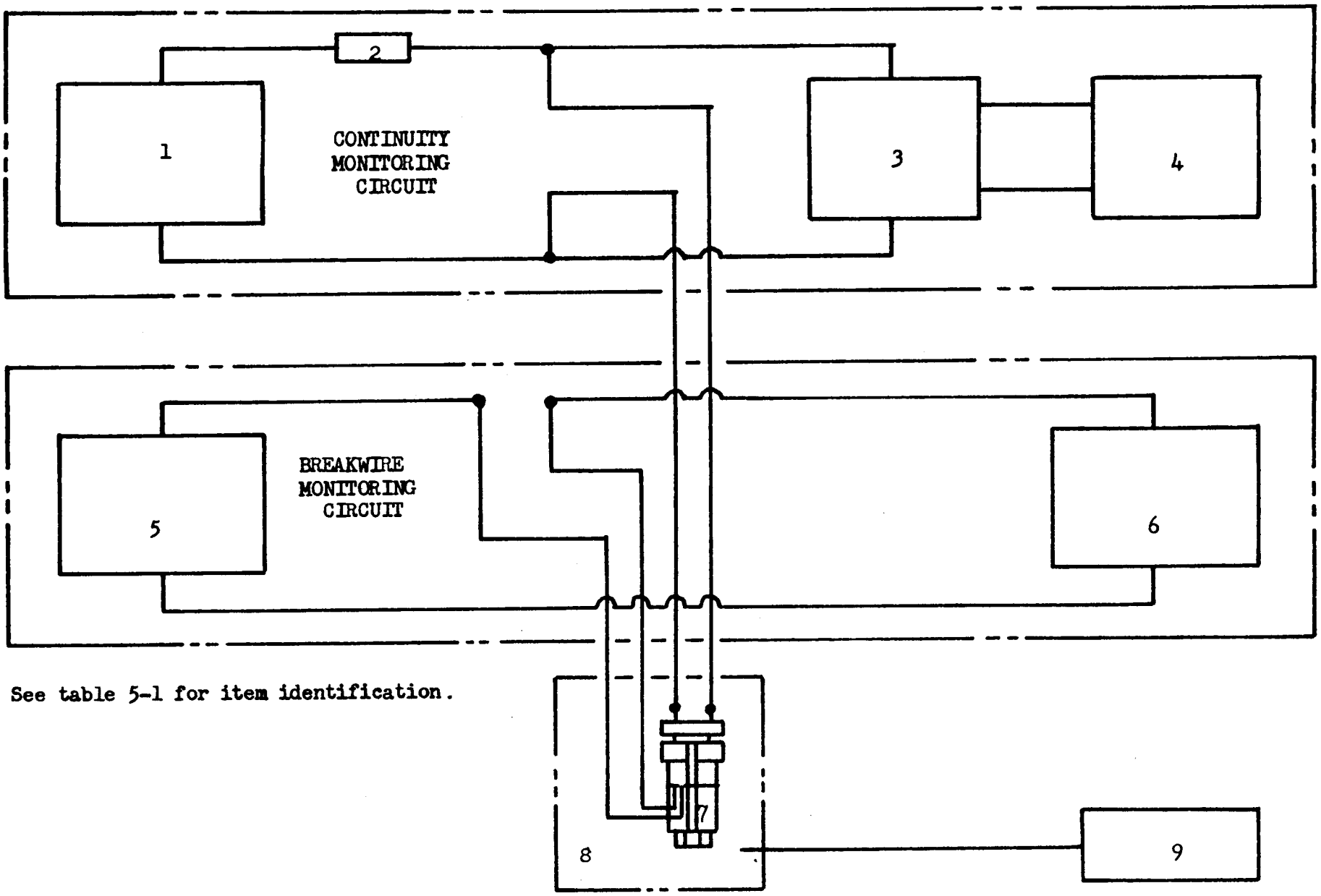
5.3.5.4 The explosion of specimen No. 16 extinguished the fire of all specimens.

5.3.6 The detonation times of specimen numbers 6 and 38 (step 5.2.11) are listed in table 5-2.

5.3.7 A photograph of the specimens after test is presented in figure 5-5.

5.4 TEST DATA

5.4.1 A summary of the temperature shock test data is presented in table 5-2.



See table 5-1 for item identification.

Figure 5-1. Temperature Shock Test Schematic

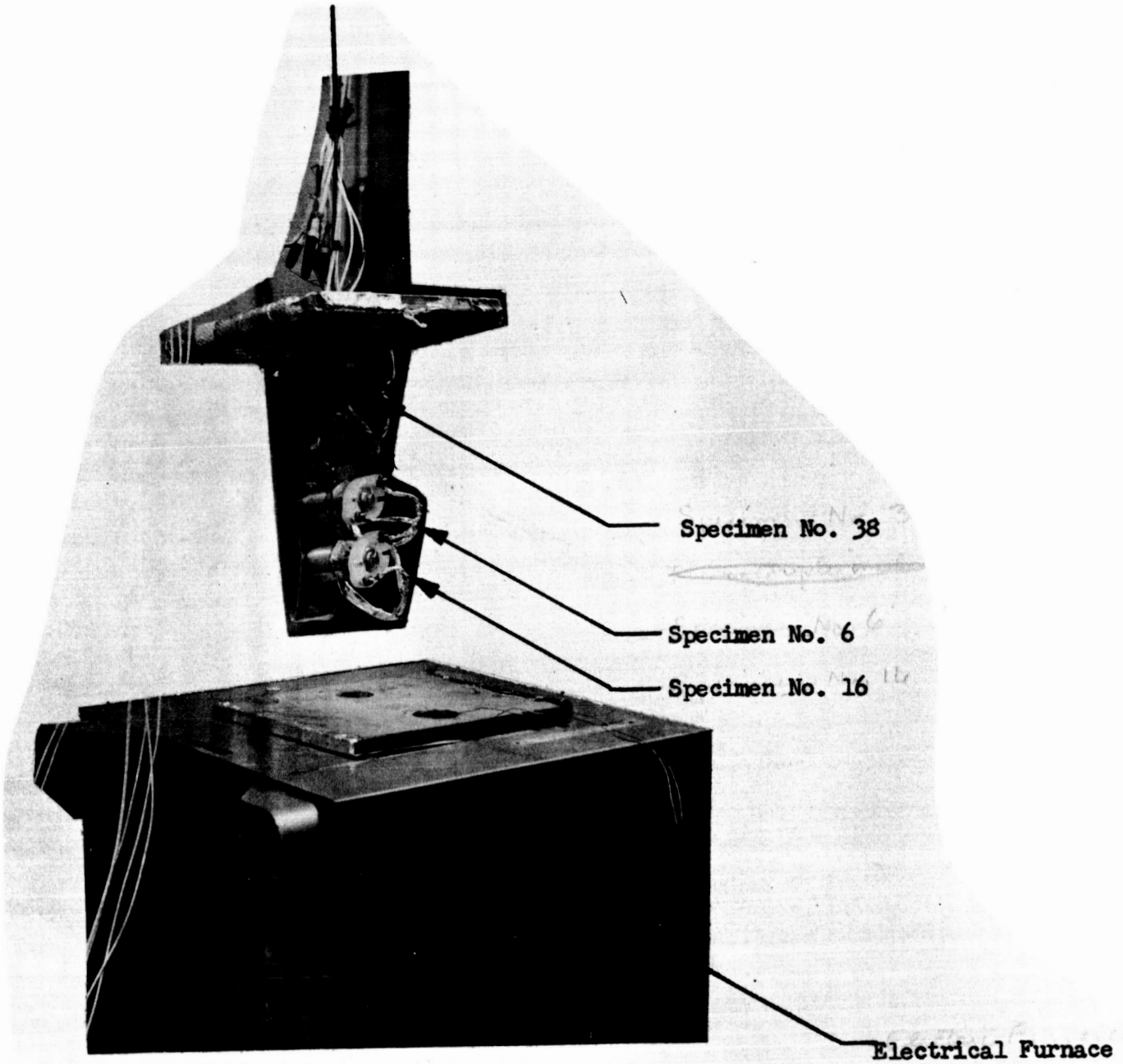


Figure 5-2. Temperature Shock Test Setup

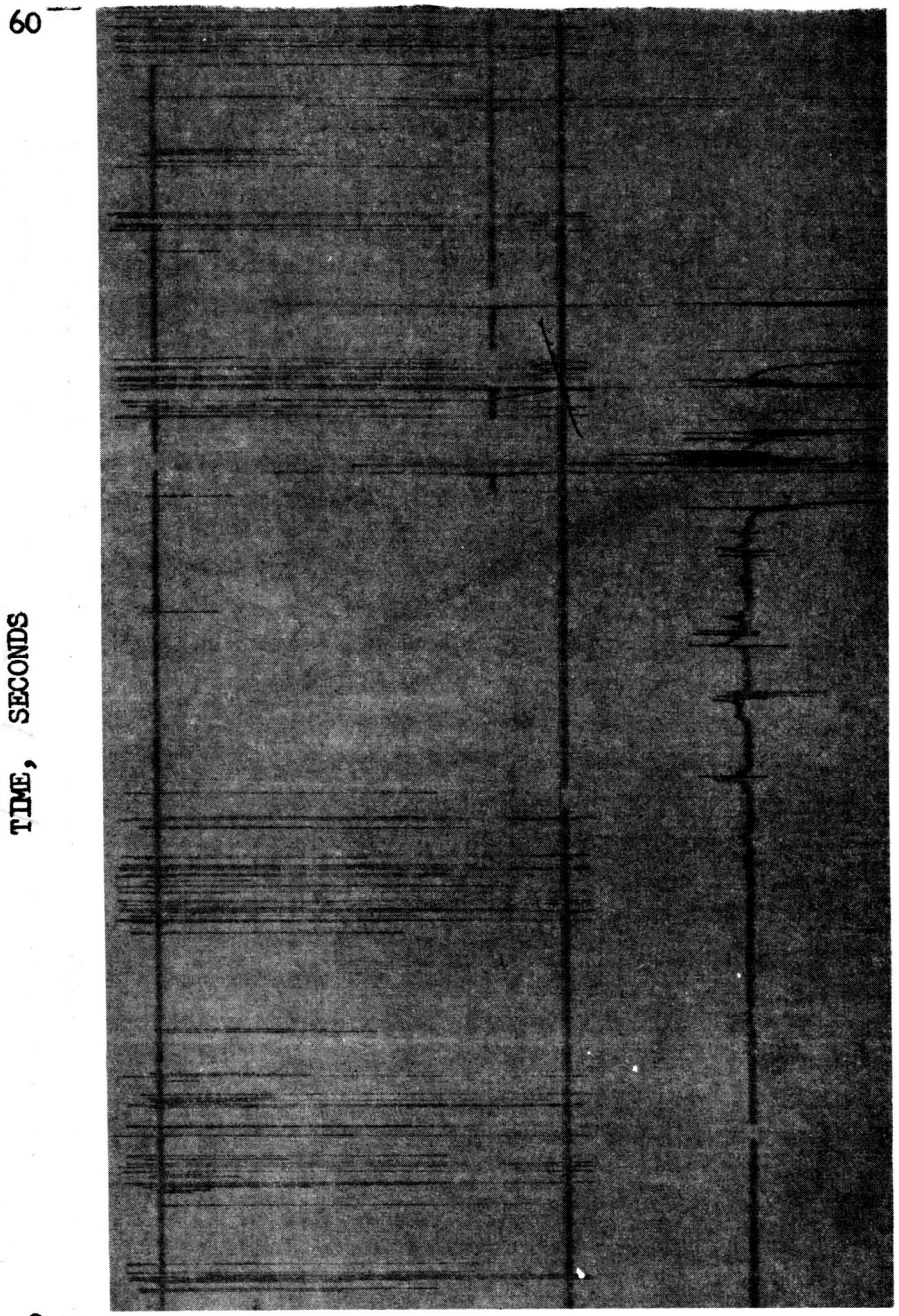


Figure 5-3. Temperature Shock Test Continuity Monitoring Recording

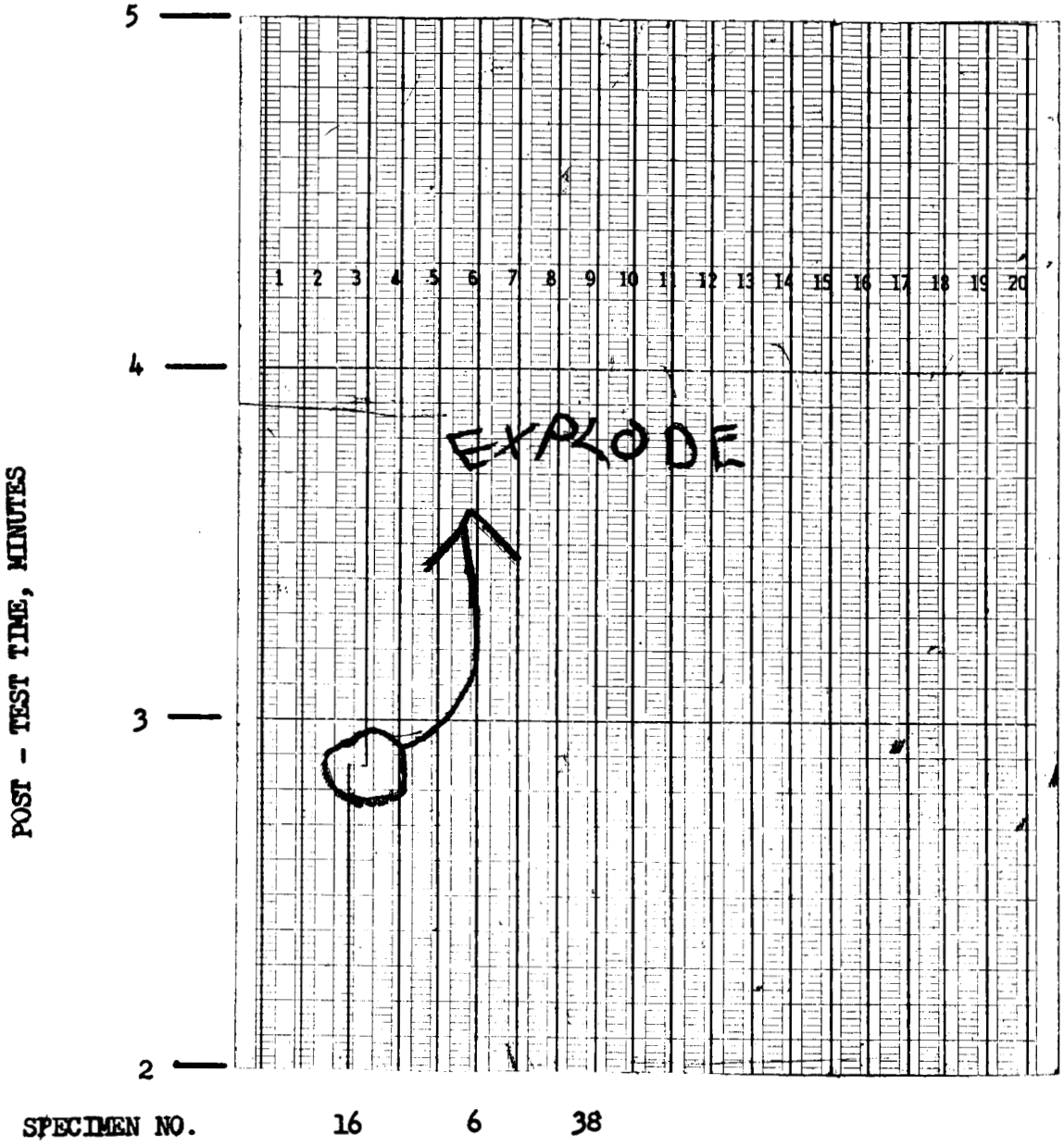
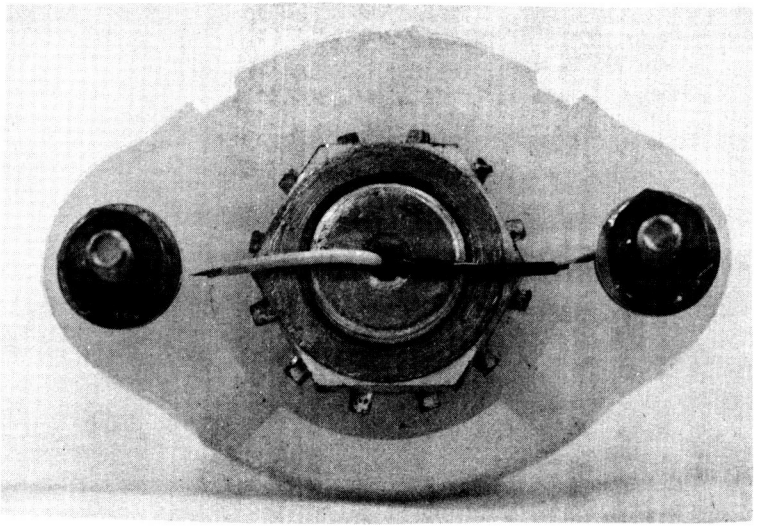


Figure 504 .Temperature Shock Test — Post-Test Breakwire Monitoring Record



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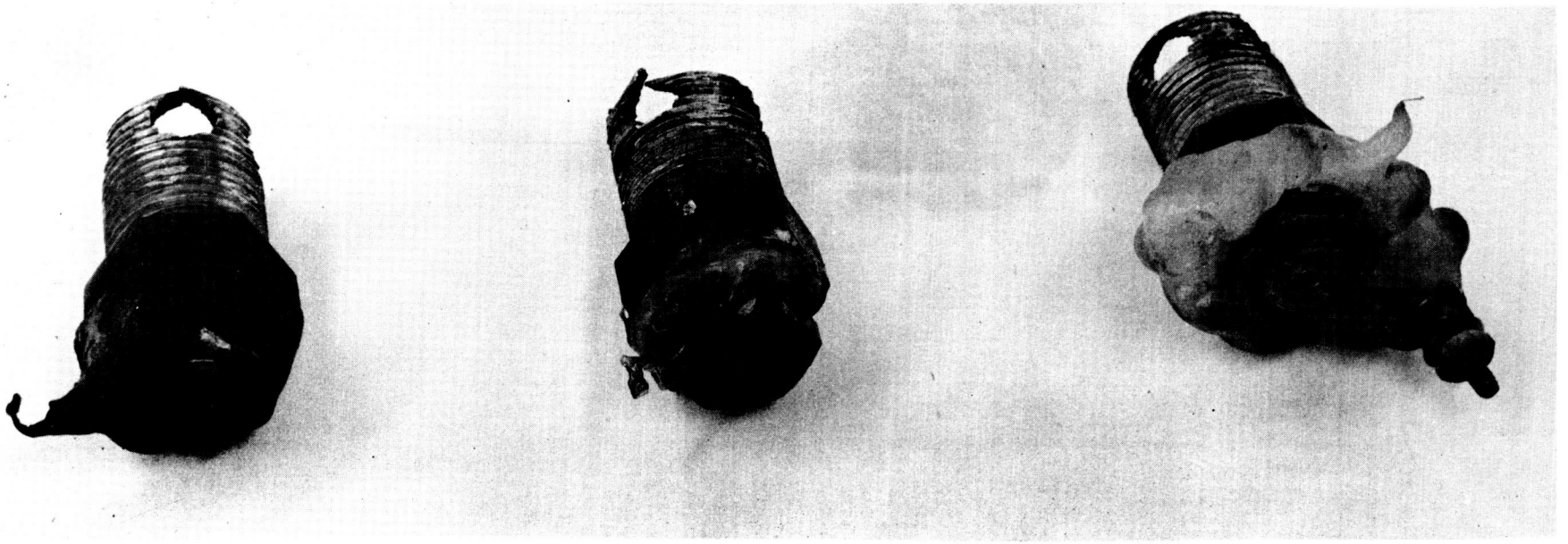

Specimen No. 6

Specimen No. 16

Specimen No. 38

Figure 5-5. Specimen after temperature shock test and detonation

Table 5-1. Temperature Shock Test Equipment List

ITEM NO.	ITEM	MANUFACTURER	PART NO.	SERIAL NO.	REMARKS
1	POWER SUPPLY	PERKINS ELECTRONICS	—	64-377	MODEL TVR 040-5 5VDC
2	RESISTOR	OHMITE	10K	—	CURRENT LIMITER
3	D.C. AMPLIFIER	ENDEVCO CORP.	—	—	MODEL 4621 (6 EACH)
4	OSCILLOGRAPH	CONSOLIDATED ELECTRO-DYNAMICS	—	6382	MODEL 5-124
5	POWER SUPPLY	LAMBDA	LA 100-03BM	—	28 VDC.
6	EVENT RECORDER	TECHNI-RITE ELECTRONICS INCORP.	—	—	NASA B.T. 010461
7	EXPLOSIVE RELEASE WITH SLOTTED NUT AND PLUG	E. I. DUPONT dE NEMOURS	X-696	6, 16, 38	—
8	ELECTRIC FURNACE	THERMOLYNE CORP.	TYPE 1600	—	3910 WATTS 115 VOLTS
9	TEMCOMETER CONTROLLER	THERMOLYNE CORP.	CP-A515T	411472	115 VOLTS 60 CYCLES

Table 5-2. Temperature Shock Test Data

SPECIMEN SERIAL NUMBER	RESISTANCE Ω		DURING TEST		AFTER TEST DETONATION			SPECIMEN TESTING TIME	REMARKS
	BEFORE TEST	AFTER TEST	CONTINUITY	DETONATION	AMPERES SUPPLIED	VOLTAGE SUPPLIED	ELAPSED TIME MILLISECONDS		
6	.43	NONE RECORDED	LOSS CONTINUITY	NO	10	28 VDC	4.02	1 MIN.	PLASTIC BODIES OF ALL SPECIMENS WERE DESTROYED BY FIRE THAT STARTED DURING TEST AND CONTINUED AFTER TEST COMPLETION
16	.43	NONE RECORDED	YES	NO	DETONATED SPONTANEOUSLY THREE MINUTES AFTER COMPLETION OF TEST			1 MIN.	
38	.40	NONE RECORDED	LOSS CONTINUITY	NO	10	28 VDC	3.85	1 MIN.	

APPROVAL

TEST REPORT

FOR

EXPLOSIVE RELEASE

NASA PART NUMBER X-696

SUBMITTED BY:

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